Aim ↬ To design and test the performance of the Full Wave Precision Rectifier using Op-Amp.

Equipment Required ↬

Op-Amp, resistors, capacitors, power supply, DSO, function generator, breadboard, and connecting wires.

Theory ↬

A full-wave precision rectifier is an op-amp-based circuit designed to convert both the positive and negative halves of an AC input signal into a unidirectional DC signal. Unlike standard rectifiers that rely on diodes and suffer from voltage drops, a precision rectifier overcomes these limitations by employing operational amplifiers (op-amps) to achieve rectification with minimal distortion, making it ideal for low-voltage signal processing applications.

A full-wave rectifier ensures that both halves of the input waveform contribute to the output, improving the efficiency and ripple frequency compared to a half-wave rectifier. In a typical precision rectifier configuration, the op-amp operates in conjunction with diodes, resistors, and feedback networks to allow for accurate signal rectification without the voltage drop commonly associated with diodes.

The key aspect of the circuit is the ability of the op-amp to drive the diodes in such a way that even small input signals are rectified. This is particularly important in precision measurement systems, where signal fidelity and low distortion are required. The circuit can be divided into two stages: the first stage rectifies the positive half of the signal, while the second stage, through an inverting configuration, rectifies the negative half.

The operation of the precision rectifier is governed by the following equations for a full-wave rectifier:

- During the positive half of the input cycle: $V_{out} = V_{in}$
- During the negative half of the input cycle: $V_{out} = -V_{in}$

The rectifier inverts the negative half of the AC waveform, resulting in a full-wave rectified output.

The diodes used in the circuit switch on and off precisely as the input signal crosses zero, ensuring accurate rectification. The feedback loop in the op-amp ensures that the output closely follows the input, reducing the forward voltage drop seen in traditional diode rectifiers.

In this experiment, the precision rectifier circuit is constructed using op-amps, diodes, resistors, and a function generator to provide the AC input. The output waveform is monitored using a Digital Storage Oscilloscope (DSO) to verify that full-wave rectification is achieved. The expected output waveform is a unidirectional signal that mirrors the magnitude of the input signal, but with both positive and negative halves rectified.

Circuit Diagram ↬

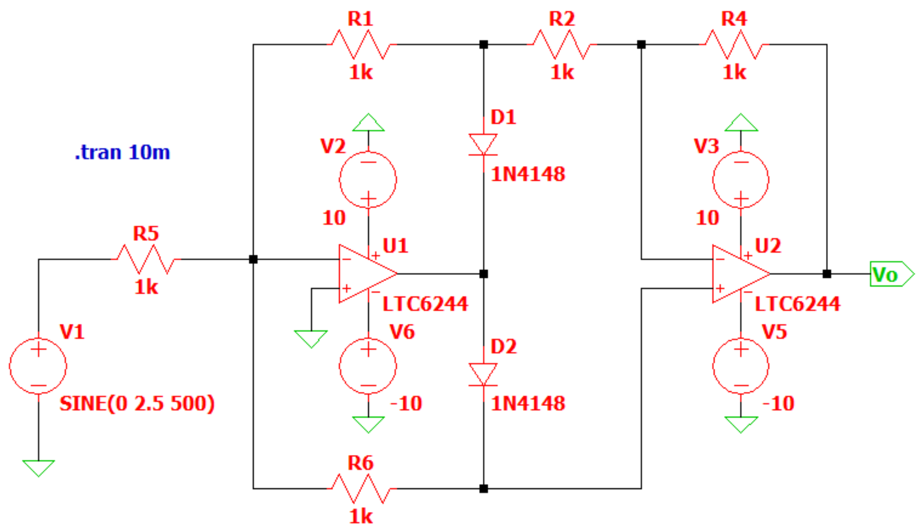

Fig. i) Circuit in LTSpice

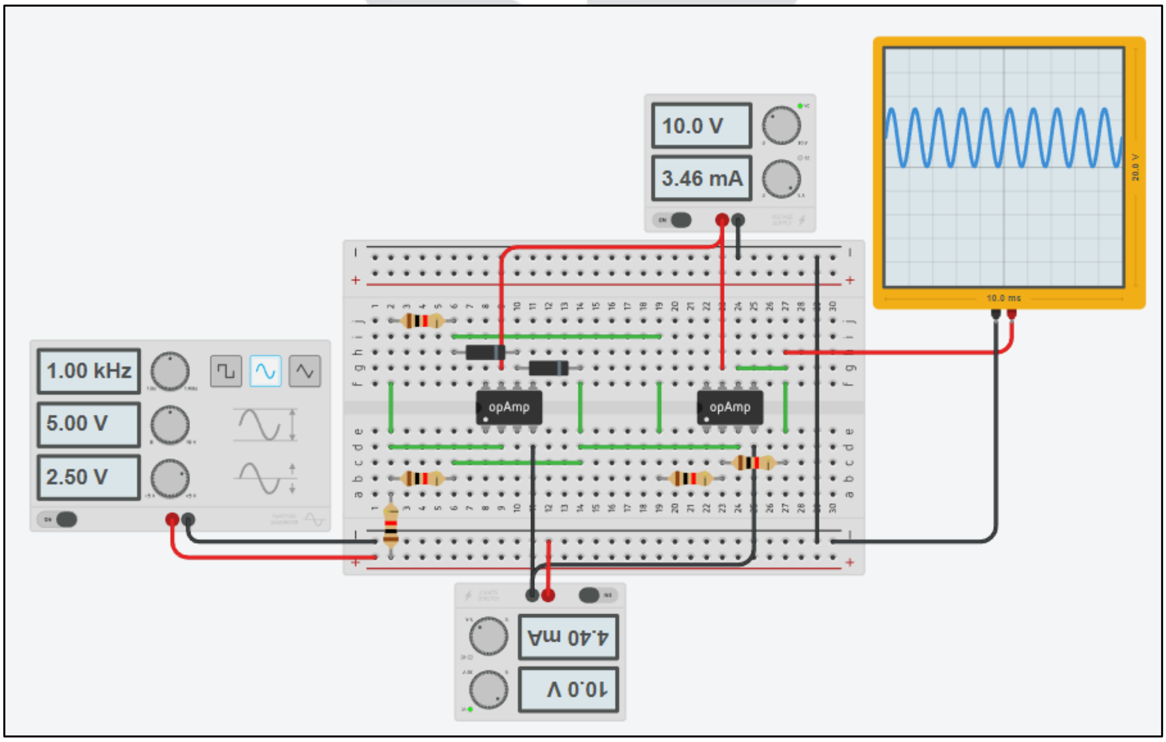

Fig. ii) Circuit in TinkerCad

Graphs ↬

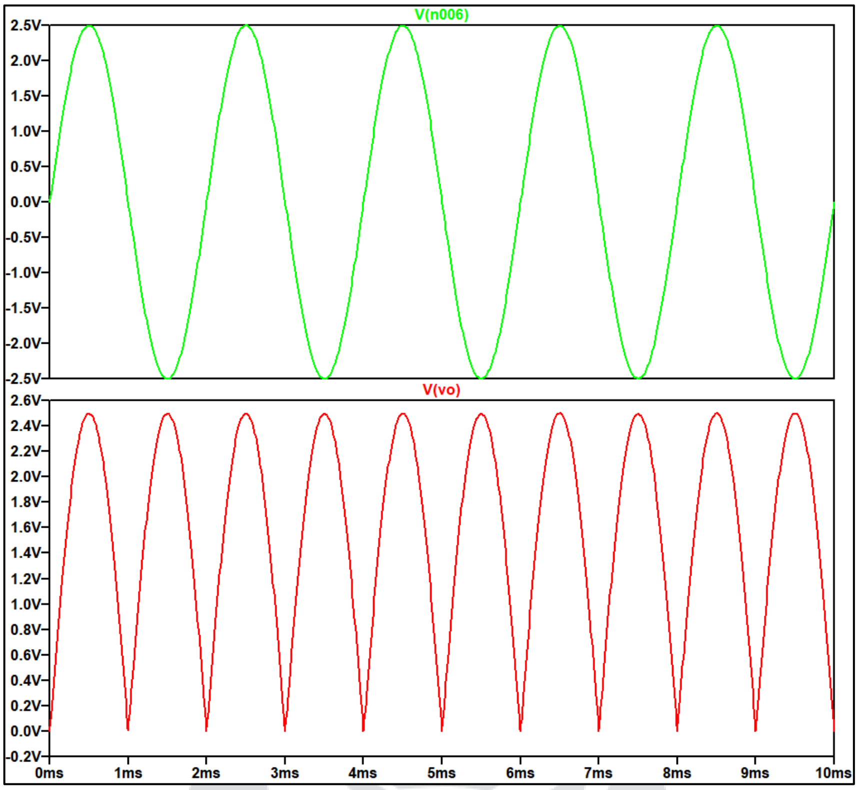

Fig. iii) Full Wave Rectification

Result ↬

The full-wave precision rectifier successfully converted the AC input into a unidirectional DC signal. The DSO showed a clean rectified output, with both halves of the input waveform accurately rectified.

Conclusion ↬

The precision rectifier was effectively designed and tested. It accurately rectified both positive and negative halves of the input, producing a smooth DC output. The op-amp eliminated the typical diode voltage drop, ensuring high-fidelity signal rectification.

Precautions ↬

- Ensure correct polarity of the diodes to achieve proper rectification.
- Double-check all component connections to avoid short circuits or miswiring that could affect the circuit's performance.
- Use appropriate op-amps with a sufficient slew rate to handle the input signal's frequency.
- Maintain supply within the op-amp's specified range to prevent damage.