Name of Experiment: - Half Wave Rectification.

Objectives:-

1. Explain Rectification
2. Explain Half Wave Rectification
3. Explain Half Wave Rectification:For Positive Half Cycle
4. Explain Half Wave Rectification:For Negative Half Cycle

Theory:-

Rectification:-

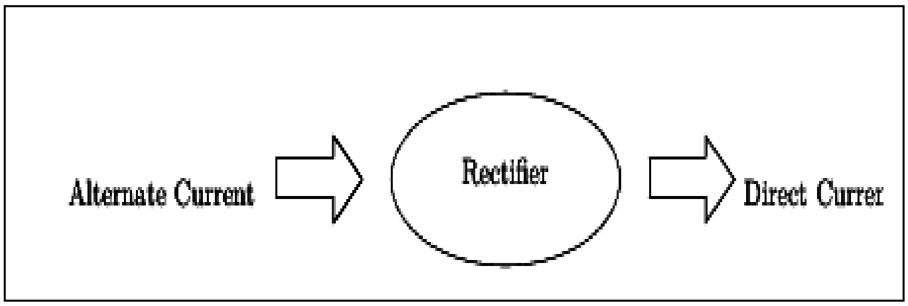

Figure: 1

A rectifier is a device that converts alternating current (AC) to direct current (DC), a process known as rectification. Rectifiers are essentially of two types – a half wave rectifier and a full wave rectifier.

Half Wave Rectification

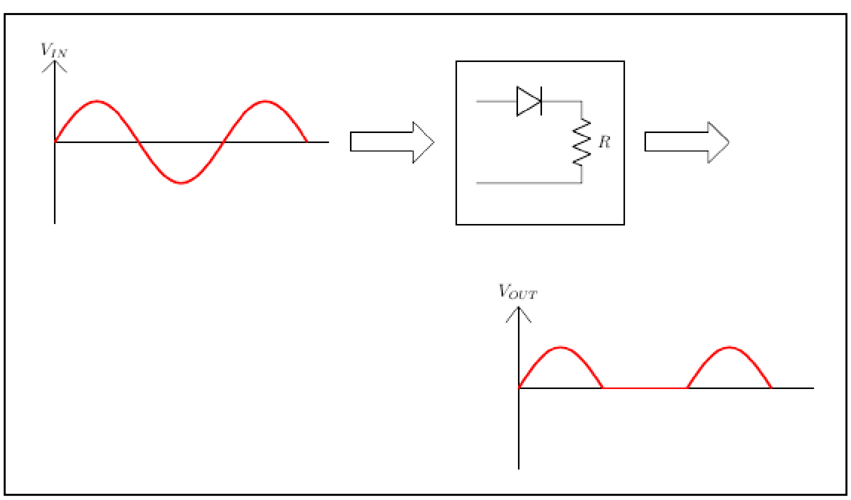

Figure- 2

On the positive cycle the diode is forward biased and on the negative cycle the diode is reverse biased. By using a diode we have converted an AC source into a pulsating DC source. In summary we have 'rectified' the AC signal.

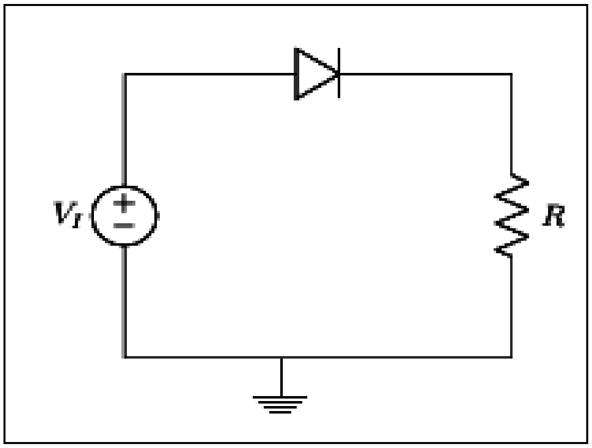

Figure- 3

The simplest kind of rectifier circuit is the half-wave rectifier. The half-wave rectifier is a circuit that allows only part of an input signal to pass. The circuit is simply the combination of a single diode in series with a resistor, where the resistor is acting as a load.

Half Wave Rectifiers- Waveform

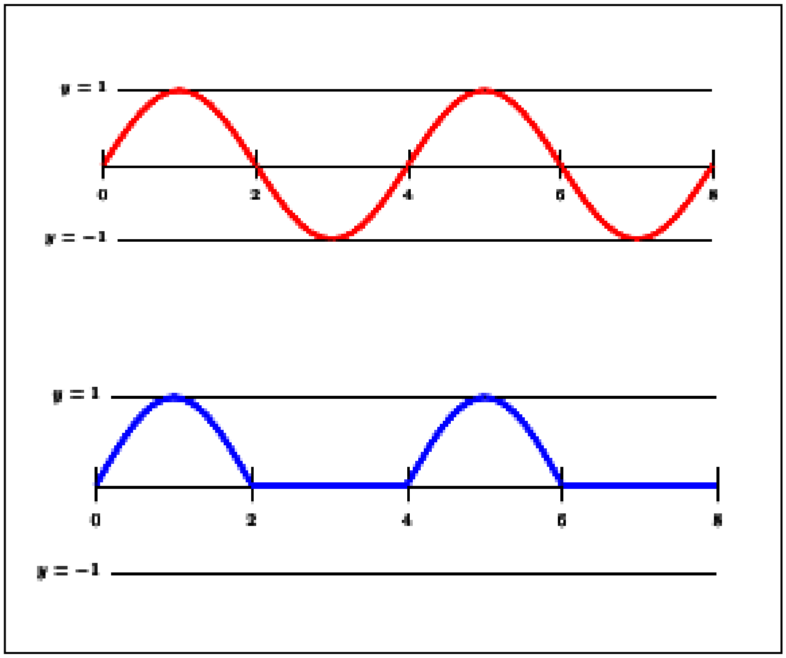

Figure- 4

The output DC voltage of a half wave rectifier can be calculated with the following two ideal equations.

$$V_{peak} = V_{rms} \times \sqrt{2}$$

$$V_{dc} = \frac{V_{peak}}{\pi}$$

Half Wave Rectification:For Positive Half Cycle

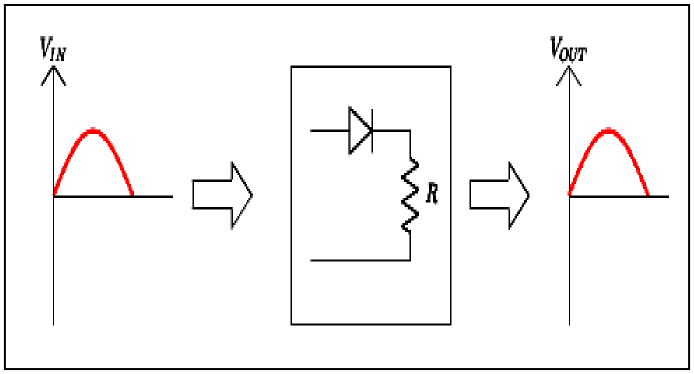

Figure- 5

Diode is forward biased, acts as a short circuit, passes the waveform through.

For positive half cycle:

$$V_I - V_b - I \times r_d - I \times R = 0$$

where,
V_I is the input voltage,
V_b is barrier potential,
r_d is diode resistance,
I is total current,
R is resistance.

$$I = \frac{V_I - V_b}{r_d + R}$$

$$V_O = I \times R$$

$$V_O = \frac{V_I - V_b}{r_d + R} \times R$$

For $r_d << R$,

$$V_O = V_I - V_b$$

V_b is 0.3 for Germanium ,
V_b is 0.7 for Silicon

For $V_I < V_b$,

The diode will remain OFF.The Output voltage will be,

$$V_O = 0$$

For $V_I > V_b$,

The diode will be ON.The Output voltage will be,

$$V_O = V_I - V_b$$

Half Wave Rectification:For Negative Half Cycle

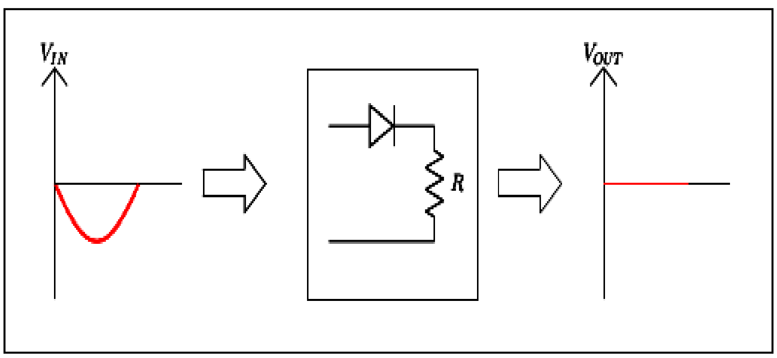

Figure- 6

Diode is reverse biased, acts as a open circuit, does not pass the waveform through.

For negative half cycle:

$$V_O = 0 \quad \text{Since,} \quad I = 0$$

Half wave Rectification:For an Ideal Diode

For Ideal Diode,

$$V_b = 0$$

For positive half cycle,

$$V_O = V_I$$

For negative half cycle,

$$V_O = 0$$

Average output voltage

$$V_O = V_m \times \sin wt \quad for \quad 0 \leq wt \leq \pi$$

$$V_O = 0 \quad for \quad \pi \leq wt \leq 2\pi$$

$$V_{av} = \frac{V_m}{\pi} = 0.318V_m$$

RMS load voltage

$$V_{rms} = I_{rms} \times R = \frac{V_m}{2}$$

Average load current

$$I_{av} = \frac{V_{av}}{R} = \frac{\frac{V_m}{\pi}}{R}$$

$$I_{av} = \frac{V_m}{\pi \times R} = \frac{I_m}{\pi}$$

RMS load current

$$I_{rms} = \frac{I_m}{2}$$

Form factor: It is defined as the ratio of rms load voltage and average load voltage.

$$F.F = \frac{V_{rms}}{V_{av}}$$

$$F.F = \frac{\frac{V_m}{2}}{\frac{V_{av}}{2}} = \frac{\pi}{2} = 1.57$$

$F.F \geq 1$
$rms \geq av$

Ripple Factor

$$\gamma = \sqrt{(F.F^2 - 1 \times 100\%}$$

$$\gamma = \sqrt{(1.57^2 - 1)} \times 100\% = 1.21\%$$

Efficiency: It is defined as ratio of dc power available at the load to the input ac power.

$$n\% = \frac{P_{load}}{P_{in}} \times 100\%$$

$$n\% = \frac{I_{dc}^2 \times R}{I_{rms}^2 \times R} \times 100\%$$

$$n\% = \frac{\frac{I_m^2}{\pi^2}}{\frac{I_m^2}{4}} \times 100\% = \frac{4}{\pi^2} \times 100\% = 40.56\%$$

Peak Inverse Voltage

For rectifier applications, peak inverse voltage (PIV) or peak reverse voltage (PRV) is the maximum value of reverse voltage which occurs at the peak of the input cycle when the diode is reverse-biased.The portion of the sinusoidal waveform which repeats or duplicates itself is known as the cycle. The part of the cycle above the horizontal axis is called the positive half-cycle, the part of the cycle below the horizontal axis is called the negative half cycle. With reference to the amplitude of the cycle, the peak inverse voltage is specified as the maximum negative value of the sine-wave within a cycle's negative half cycle.

Procedure

1. Set the resistor R_L.
2. Click on 'ON' button to start the experiment.
3. Click on 'Sine Wave' button to generate input waveform
4. Click on 'Oscilloscope' button to get the rectified output.
5. Vary the Amplitude, Frequency, volt/div using the controllers.
6. Click on "Dual" button to observe both the waveform.
7. Channel 1 shows the input sine waveform, Channel 2 shows the output rectified waveform.
8. Calculate the Ripple Factor.Theoretical Ripple Factor= 1.21.

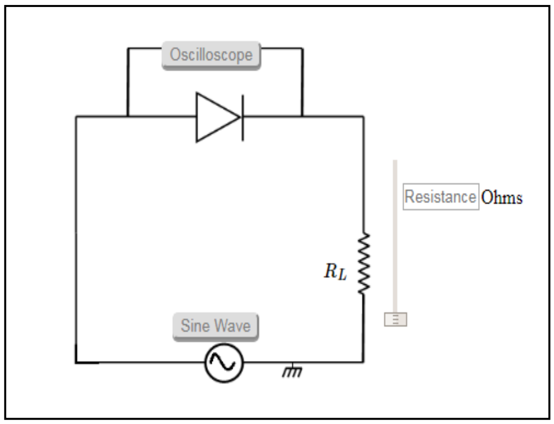

Figure- 7

Calculation

Measure the V_m

$$V_{rms} = \frac{V_m}{2}$$

$$V_{dc} = \frac{V_m}{\pi}$$

Ripple Factor= $\frac{V_{ac}}{V_{dc}}$ Since, $V_{ac} = \sqrt{(V_{rms}^2 - V_{dc}^2)}$