Experiment: HALF WAVE RECTIFIER

Aim:

a) To build a half –wave rectifier circuit with given component values on a breadboard (without and with a capacitor)

b) To observe the output waveforms on the oscilloscope.

c) To calculate the peak value, RMS value and ripple factor of the output waveforms

d) To plot the input and output waveforms on a graph sheet to scale.

Equipment and Components: Cathode Ray Oscilloscope (CRO), Signal generator, Multimeter, Breadboard, Probes, and connecting wires; Diode- Model number (e.g., 1N4007), Resistor, Capacitor.

Theory: Half-wave rectifier is primarily used to convert an ac signal into a DC signal. Power transmitted from power stations is an AC signal (220V/50 Hz) whereas most of the home appliances or other electrical equipment we use in our day-to-day life require DC power. The method by which we convert a given AC signal into a DC signal is called 'rectification.' In this experiment, one of such basic circuits used for rectification is built.

Operation: Consider the circuit shown in fig. 1. An input signal as shown in fig. 3 is applied. During the positive half of the input sinusoidal signal, the diode is forward biased and is conducting. The diode has a very low resistance in the forward bias state. The output, taken across the resistor 'R' in fig. 1, almost follows the input after a drop of around 0.

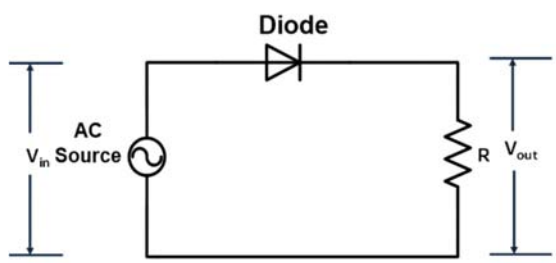

Fig. 1: Half wave rectifier circuit without a capacitor filter

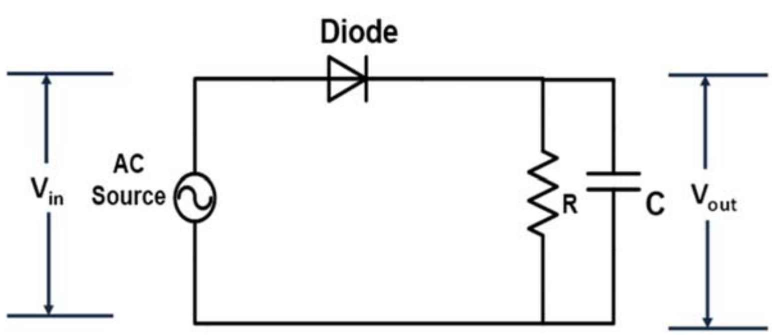

Fig. 2: Half wave rectifier circuit with a capacitor filter

One the input voltage is greater than the cut-in voltage of the diode, the voltage across the resistor is equal to V_{in} - V_{cutin}. During the negative half cycle of the input signal, the diode is reverse biased and has a very large resistance. The reverse bias prevents any current flowing through the resistor ‘R.’ Hence the output voltage is zero in the negative half cycle. The output waveform is shown in fig. 4.

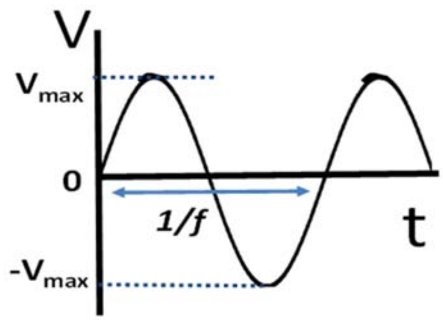

Fig. 3: Input sinusoidal waveform applied to the half-wave rectifier circuit

A capacitor C is connected across the load resistor as shown in fig. (2). During the positive half cycle, the circuit is conducting, and the capacitor is quickly charged to the peak value of the input signal as the time constant during the positive cycle ($\tau = \frac{RR_f}{R+R_f}C$) is very low. Here ‘$R_f$ ‘ is the forward resistance of the diode. Voltage measured across the resistor is equal to input voltage.

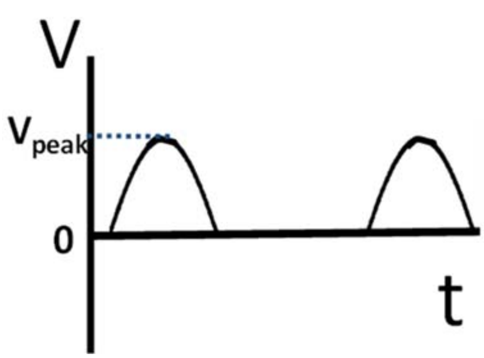

Fig. 4: Output waveform of the halfwave rectifier circuit without a Capacitor filter (For the circuit shown in Fig (1))

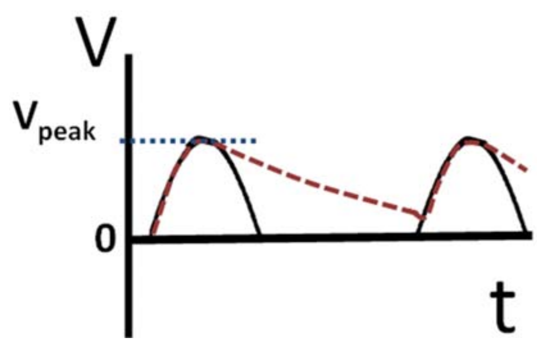

Fig. 5: Output waveform of the halfwave rectifier circuit with a Capacitor (For the circuit shown in Fig (2))

During the negative half cycle, the diode is reverse biased, and the diode does not conduct. The capacitor then slowly discharges its charge into the resistor ‘R.’ The time constant ($\tau = RC$) is relatively high for this case.

Experiment Procedure

1. Connect the circuit shown in Fig (a) (without capacitor) on the breadboard.
2. Apply a sinusoidal signal of a given frequency f across V_{in} and observe the waveforms across V_{out} in fig. 1. Observe the input waveform using channel 1 of the oscilloscope and output of the circuit using channel 2 of the oscilloscope.
3. Trace the input waveform and the output waveforms with respect to the input waveform to scale on a graph sheet as per the scale.
4. Using the XY mode in an oscilloscope, trace the input versus output waveform.
5. Now connect the circuit given in fig. 2 (with a capacitor) and repeat steps 2 and 6.

Observations:

	Without the capacitor	**With the capacitor**
AC Input voltage (V_{RMS})		
DC output voltage (V_{DC})		
DC current (I_{DC})		
AC output voltage (Ripple voltage, V_r)		
Ripple factor $\left(\frac{V_r}{V_{DC}}\right)$		

Observed Waveforms:

Without capacitor:

With capacitor:

Conclusion: