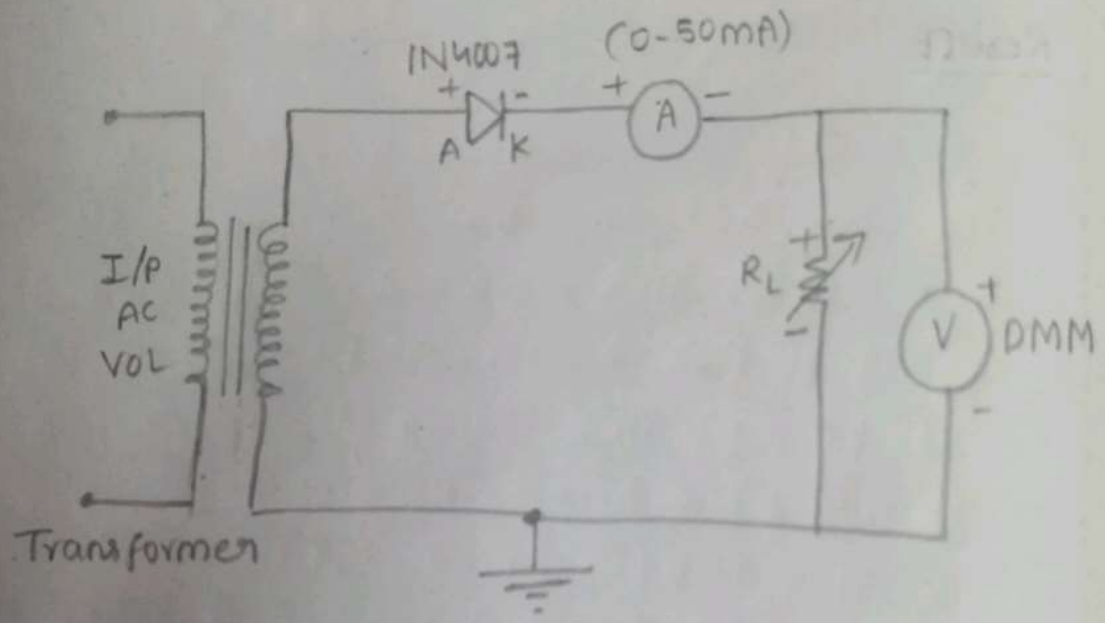
Circuit diagram

Half Wave Rectifier



Rectifiers without filters

Aim: To study the half wave and full wave rectifier circuits without filters.

Apparatus

1. Ammeter	0-50 mA	-1
2. Digital multimeter		-1
3. Decade resistance box		-1

Components

1. Diode IN4007	-2
2. Transformer - 230V/120-12, 500mA	-1

Theory

Rectifier: A device, such as the semiconductor diode, which is capable of converting a sinusoidal input waveform (whose average value is zero) into a undirectional (though not constant) wave form with a non-zero average component is called a rectifier.

The functions of various circuits are listed below:

1. **Transformer:** It adjusts the AC level such that the approximate DC amplitute is achieved.
2. **Rectifier:** A device, such as the semiconductor diode, which is capable of converting input.
3. **Filter:** 'smoothes' the waveform by eliminating the AC component from the rectifier output.

Peak inverse Voltage

The peak inverse voltage (PIV) or PRV (Peak reverse voltage) rating of the diode is the primary importance of the design of rectification system. It is the voltage rating that must not exceeded in the reverse bias region of the diode.

In a halfwave rectifier, when the diode is reverse biased, the voltage appears accross diode is 'V_i' and its maximum value is V_m. This V_m should not exceed the PIV of the diode. Otherwise the diode will enter into the breakdown region.
For halfwave rectifier PIV rating $> V_m$.

Full wave Rectifier

The circuit of the full wave rectifier is shown below This circuit is seen to comprises of two half-wave circuits connected so that conduction takes place and through one diode during one half cycle and through other diode during the second half of the cycle.

During the positive half cycle of the input signal D_1 is forward biased and i_1 current flown through D_1 and R_L. During negative half cycle of the signal D_2 is forward biased and i_2 current flowing through D_2 and R_L. The current to load, which is the sum of these current, is $i = i_1 + i_2$ the DC and RMS values of the load current and load voltages are

I_{dc} = Average value

= Area of one cycle of current divided by the base of current

$$I_{dc} = \frac{1}{\pi}\int_0^{\pi} I_m \sin\alpha \, d\alpha = \frac{I_m}{\pi}\left[-\cos\alpha\right]_0^{\pi}$$

$$= -\frac{I_m}{\pi}(-2) = \frac{2I_m}{\pi}$$

where $I_m = \frac{V_m}{R_f + R_L}$ $\cdot V_{dc} = I_{dc} \cdot R_L = \frac{2I_m R_L}{\pi}$

V_m is the peak transformer secondary voltage from one end to the center tap.

The dc output voltage of the full wave rectifier circuit is twice that for the half wave rectifier circuit. Because the area above the axis for one full AC input cycle is twice that obtained for a half-wave system

$$I_{rms}^2 = \frac{1}{\pi}\int_0^{\pi} I^2 m \sin^2\alpha \, d\alpha = \frac{I^2 m}{\pi}\int_0^{\pi}\left(\frac{-\cos 2\alpha}{2}\right) d\alpha$$

$$= \frac{Im^2}{2\pi}\left[\alpha - \frac{\sin 2\alpha}{\alpha}\right]_0^{\pi}$$

$$= \frac{Im^2}{2}$$

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

Peak inverse Voltage

When any one of the two bodies is reverse biased the maximum voltage appears accross that open circuit. This can be solved by following equivalent circuits.

By applying KVL we can find out V_{AB} or V_{CD}

$$V_{AB} = V_{CD} = 2V_m$$

Thus when any diode is reverse biased, then a maximum of $2V_m$ appears accross that diode. For safe operation, the PIV rating of that diode should be greater that or equal to $2V_m$

$$PIV \geq 2V_m \text{ For center top transformer full wave rectifier.}$$

Full wave rectifier

S.NO		Input	Output

Theoritical calculations :

Half wave rectifier

S.NO		Input	Output

Theoritical calculations :

Procedure

Half wave Rectifier

1. Connect the circuit as shown
2. Give input from AC mains.
3. Now connect the DRB. Vary the DRB and note the values of I_{dc} in steps of 10mA until the current reaches 100mA.
4. At each step measure the V_{DC} and V_{AC} values. Calculate ripple factor 'r' as ratio of V_{DC} and V_{AC}.
5. Observe the output waveforms on CRO.

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Discussions

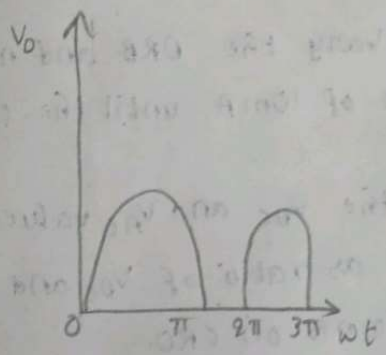
1) A rectifier is a device which converts alternating current into unidirectional current.

2) If the applied voltage in reverse biased condition exceeds PIV, then diode may get damaged.

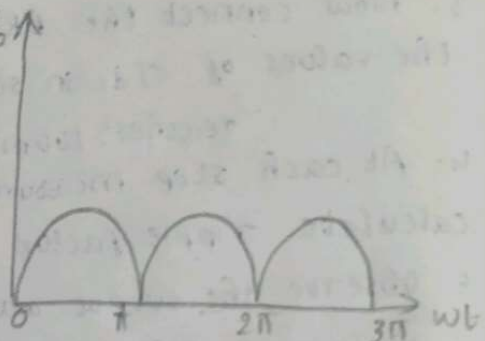
3) The type of supply available from the half wave rectifier is not satisfactory to general power supply. So half wave rectifiers are not used in the DC power supply.

Model graphs

Half wave rectifiers



Full wave rectifier



Precautions

1. Never remove or insert a diode into a circuit with voltage applied.
2. When testing a diode, ensure that the test voltage did not exceed the diode maximum allowable voltage.
3. Ensure a replacement diode into a circuit was in the correct direction.
4. The correct connection of the transformer is made sure.

Result

Wave forms of the half wave and full wave rectifiers without Filters are observed on CRO.