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Experiment No.3

Full Wave Single Phase Uncontrolled Rectifier

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Objective :

To study the single phase full wave rectifier.

Apparatus Used :

1. ST2712 board 2. AVO meter. 3. Oscilloscope. 4. Resistances 10Ω and 270Ω
5. Inductor 272 mH.

Theory :

Figure (1) shows the two configuration circuit of full wave uncontrolled rectifier, namely center tapped circuit and bridge circuit. The two circuit give the same output waveforms and they are different in the following main aspects:

- In center tap circuit there is only two diodes while in bridge circuit there are four diodes.
- In center tap circuit, the maximum voltage across the diode in off state is 2Vm while in bridge circuit is only Vm.

Single phase full-wave diode rectifiers are two pulse circuit since the fundamental ripple frequency is twice the ac supply frequency. With a resistive load or partially inductive load, the current in the ac circuit is continuous and the diodes always commutate at zero crossing of the ac source voltage. Hence the dc voltage waveform consists of successive half-cycles of a sine wave, independent of the load type. In effect, the two diodes that are tied to the positive dc terminal connect it to the ac terminal which is instantaneously more positive. Similarly, the two diodes that are tied to the negative dc terminal (in the bridge circuit) connect it to more negative ac terminal.

If the load is purely resistive, the dc current have the same shape as the output voltage except that the amplitude is multiplied by $1/R_L$. The average value of the output dc voltage is given by:

$$Vmean = \frac{1}{\pi}\int_0^{\pi} Vm\sin(wt)d\,(wt) = \frac{2Vm}{\pi} = 0.636\,Vm$$

The rms value of the output voltage is

$$\text{Vrms} = \sqrt{\frac{1}{\pi}\int_0^{\pi}(Vm\sin wt)^2\,d(wt)} = \frac{Vm}{\sqrt{2}} = 0.707\,Vm$$

Where Vm is the maximum value of the input voltage, and Vrms is the r.m.s. value.

Two pulse circuit have limited practical value of high power applications because of the large ripple which is contained in the dc output voltage. It is readily seen that the ripple has peak-to-peak value of Vm and contains all even harmonics of the ac frequency.

In case of inductive load the ripple current is ordinary reduced (see figure 1). In practice, part or all of this inductance is frequently in the load itself, as in case of a motor armature or field. However for the sake of discussion, the inductance will be considered as a filter which is a part of the rectifier. In order to obtain a smooth dc output voltage a filter capacitor is used (see figure 1).

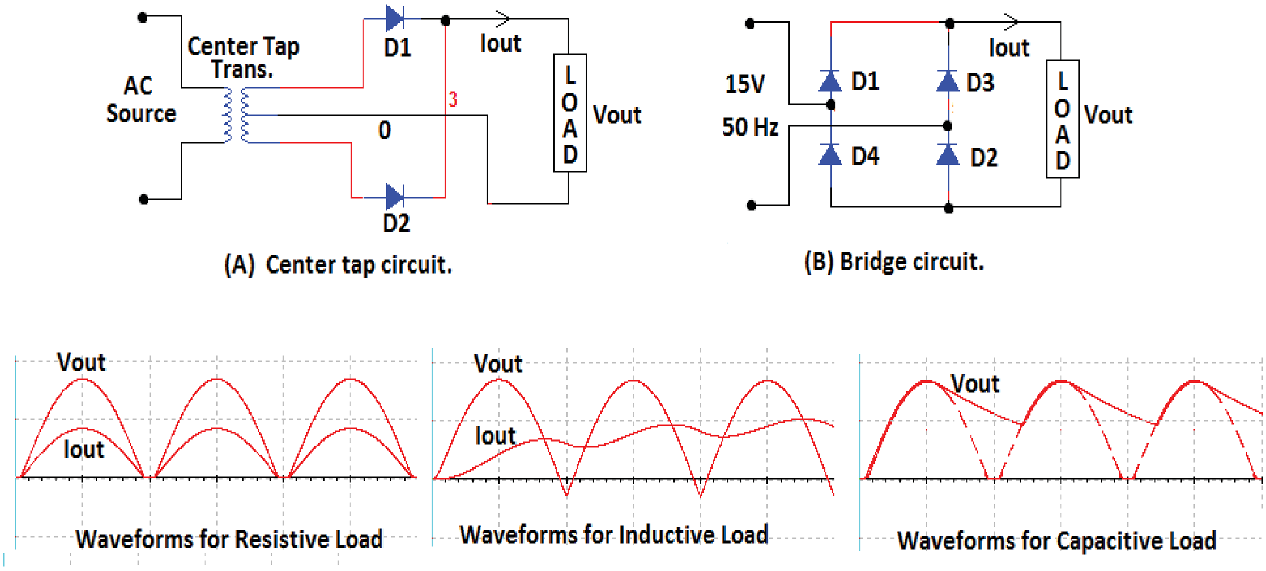

Figure (1) Full wave single phase rectifier circuit and waveforms for different types of load.

The following formulas are valid for full-wave rectifier with capacitor filter :

$$Vdc \quad = 0.5Vmax \left(1 + e^{-1/(2FRC)}\right)$$

And the approximation expression is,

$$Vdc \ = Vmax \ (\ 1 - 1/(4FRC))$$

R.F. = Vr(rms) / Vdc

Vr(rms) = $\left(\frac{Vmax}{4\sqrt{3}FRC}\right)$

Then,

$$R.F. = \frac{\left(\frac{Vmax}{4\sqrt{3}FRC}\right)}{Vmax\ (\ 1 - 1/(4FRC))} = \frac{1}{4\sqrt{3}FRC - 1}$$

Procedure :

1. Connect the circuit as shown in figure (2) for center tap circuit.
2. Switch on the power supply of the board.
3. Measure the load dc and ac voltage values, record the results in table I.
4. Display the load voltage waveform and the voltage waveform across one diode on the oscilloscope and plot displayed waveforms in your graph paper.
5. Switch off the power supply.
6. Repeat the steps above for bridge circuit in figure (3).

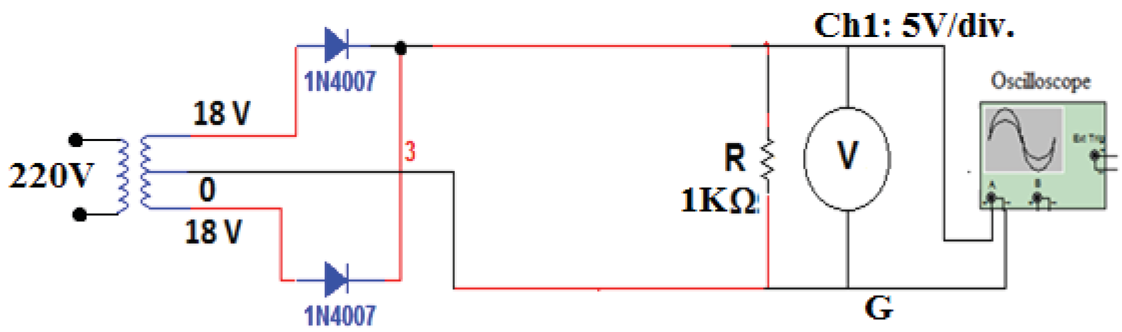

Figure (2) Practical circuit for full-wave center tap single phase rectifier with R load.

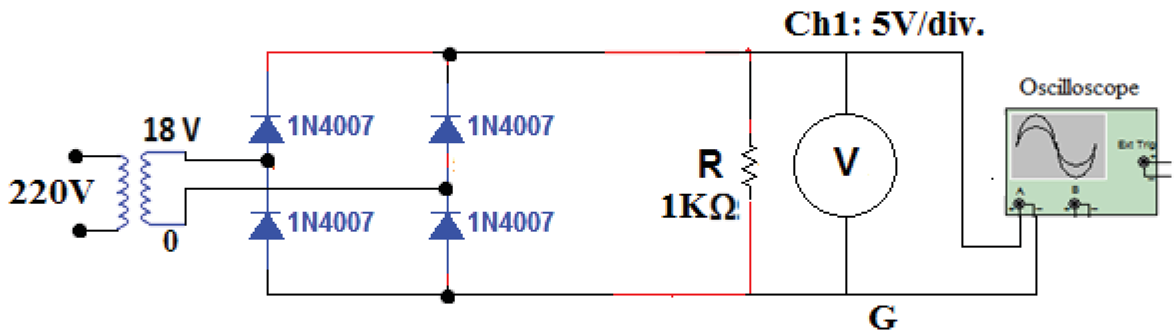

Figure (3) Practical circuit for full-wave Bridge single phase rectifier with R load.

Table (I) experimental results.

Circuit type	Load Type	Value	V_{load} (dc)	V_{load} (ac)	V_{load} (rms)	F.F.	R.F.	η (%)
Center Tap	R	1KΩ						
Bridge	R	1KΩ						

Discussion.

1- Compare between 1-Q F.W.R & 1-Q H.W.R ?
2- Draw D1 waveform theoretically and compare with the practical results, then find the (PIV) of the diode for each circuit?
3- If D1 off in bridge or center tap cct., find Vo(mean) & Vo(r.m.s) ?
4- Compare between the tow cct. of the 1-Q F.W.R (center tap & bridge) and any of them you prefer and, why ?
5- To decrease the ripple voltage what do you prefer, connect capacitor or increase no. of phases and, why ?
6- For the cct. shown bellow find Vo(mean) & Vo(r.m.s) ?