Winter Semester (2018-2019) / 3rd Grade

Experiment No: 4

Center-Tapped Full-Wave Rectifier

Instructors: Mr. Safaa Al-Waely, Eng. Mrs. Amani, Mr. Ali M. Jabbar

Objective

1- Plotting input and output waveforms of a full-wave rectifier.

2- Finding ripple factor of a full-wave rectifier.

Components

Name	Specifications
Diode 1N4001 (Si)	PIV : 50 V Forward current: 1 A
Resistors	1 kΩ, 500 Ω, 100 Ω

Equipment

Name	Specifications
Bread board / Circuit Panel	
AC Power Supply Or Step-down Transformer	0-30 V 220V to 12 V
Digital Ammeter	200 mA
Digital Voltmeter	30 V
Connecting Wires	

Theory

The electric transformer has always two coils: primary and secondary. One type of the electric transformer is called a center-tapped transformer (CTF). In such transformer, the input electric AC voltage is applied to the primary coil, and the output voltage is taken from the secondary coil. Two types of **CTF** are available: step-down, in which the output voltage is less than the input voltage, and step-up transformer by which the output voltage is raised to some amount of the input voltage. This happens according to turn ratio of the transformer, that is, if the number of secondary turns is less than that of primary coil, then a step-down transform (SDT) is produced. As shown in Fig. 1, in SDT, for example, a 220 Vac can be transformed to a 12 Vac at the whole secondary coil, or 6 Vac at each terminal with the center tap terminal (C.T.).

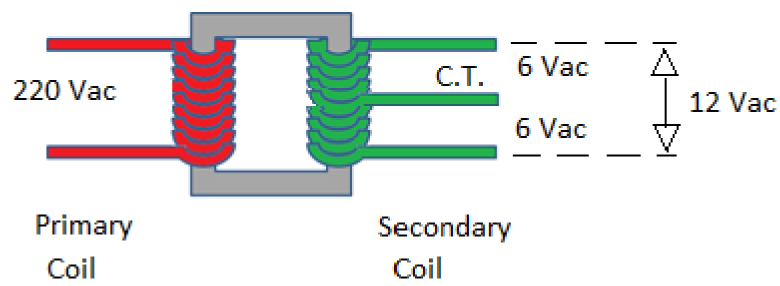

Fig. 1. Step-down center-tapped transformer

To form the connections required for the center-tapped full-wave rectifier circuit, one has to connect the circuit shown in Fig. 2, considering the C.T. terminal is grounded.

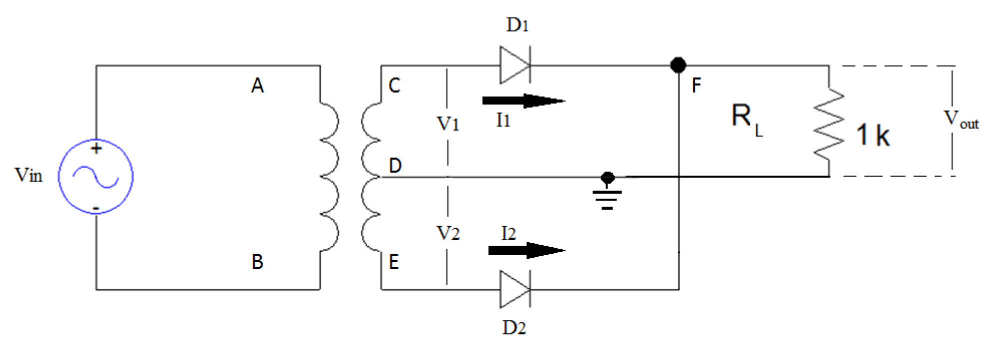

Fig. 2. Center-tapped full-wave rectifier circuit.

Note that the current path starting from point **C** to **D** passing through diode D_1 and resistor R_L is the same as already seen in the half-wave rectifier. In the second tap of the secondary coil, the same path is also seen starting from point E, point F to point **D** through resistor R_L.

<u>Circuit operation</u>

We restrict our experiment is only to a step-down transformer. The output of the transformer, e.g. 12 Vac, is divided between it two taps, each has 6 Vac, and this voltage acts an input fed to the circuit. During the positive half-cycle of the input voltage ($0 - \pi$), diode D_1 is forward biased and diode D_2 is reverse biased. Therefore, on point F, the positive-half cycle presents, and the current will pass through resistorR_L to point D. It is seen in Fig. 3 that the positive-half cycle is less than the input voltage by V_b. When the wave changes to negative ($\pi - 2\pi$), diode D_2 is forward biased and diode D_1 is reverse biased. This part of the input wave will present as a positive cycle on the load. Because the area under the curve of the full-wave rectifier signal is twice that of the half-wave rectifier, the average or dc value of the full-wave rectified signal, Vdc, is twice that of the half-wave rectifier.

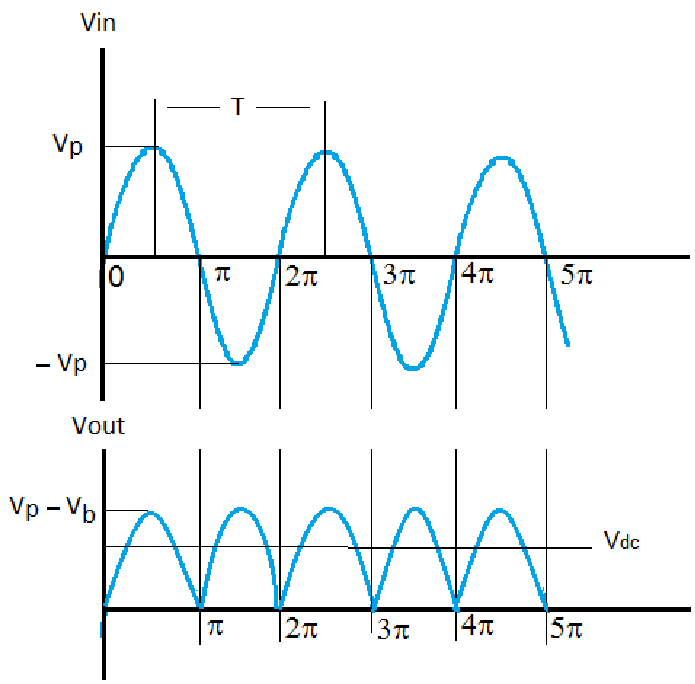

Fig. 3. Full-wave rectifier waveforms

The DC voltage at the output Vout is given by

$$V_{dc} = \frac{2(V_P - V_b)}{\pi}$$

where V_b is the built in voltage. Furthermore, the DC current passing through R_L can be calculated as

$$I_{dc} = \frac{V_{dc}}{R_L}$$

$$= \frac{2(V_P - V_b)}{\pi R_L}$$

Also, the root-mean-square voltage measured by a voltmeter is given by

$$V_{rms} = \frac{V_P}{\sqrt{2}}$$

Then, the ripple factor (R.F), which is defined as the ratio of V_{rms} value of the ripple voltage to the absolute value of the DC component of the output voltage, can be given by

$$R.F = \sqrt{\left(\frac{V_{rms}}{V_{dc}}\right)^2 - 1} \quad (1)$$

$$= \sqrt{\left(\frac{V_p/\sqrt{2}}{2V_p/\pi}\right)^2 - 1}$$

$$= \sqrt{\left(\frac{/\pi}{V_p/\sqrt{2}}\right)^2 - 1}$$

$$= 0.48$$

If one uses a voltmeter, the ripple factor is then given by

$$R.F = \frac{V_{ac}}{V_{dc}} \quad (2)$$

<u>Procedure</u>

1- Connect the circuit diagram shown in Fig. 2. Consider point C as ground.

2- Connect CH1 of the oscilloscope between point C and D, and CH2 to the load.

3- Measure Vout by a voltmeter.

4- Plot the AC input voltage of the rectifier and measure its frequency.

5- Plot the DC output voltage of the rectifier.

6- Change the load to **0.5** kΩ and repeat steps 3 through 5.

7- Change the load to **100** Ω and repeat steps 3 through 5.

<u>Calculations</u>

1- Calculate ripple factor using Eq. 1. And Eq. 2.
2- Arrange a table including all the measured parameters according to R_L.

<u>Discussion</u>

1- Compare among the values of **R.F**.

2- Discuss your results stating the error sources.