
EXPERIMENT

Full wave bridge rectifier circuit with and without filter

1 Objectives

1. To construct a full-wave bridge rectifier circuit and analyze its output.
2. To analyze the rectifier output using a capacitor in shunt as a filter.

2 Circuit components/equipment

1. A step-down transformer
2. Junction diodes
3. Load resistors (1.2 k Ω , 6.6 k Ω , 180 k Ω)
4. Capacitor (1 μ F, 10 μ F, 50 μ F)
5. Oscilloscope
6. Multimeters
7. Connecting wires
8. Breadboard.

3 Theory

A half-wave rectifier circuit is unsuitable to applications which need a “steady and smooth” DC supply voltage. One method to improve on this is to use every half-cycle of the input voltage instead of every other half-cycle. The circuit which allows us to do this is called a Full-wave Rectifier. Here, unidirectional current flows in the output for both the cycles of input signal and rectifies it. The rectification can be done either by a center tap full wave rectifier (using two diodes) or a full wave bridge rectifier (using four diodes). In this experiment we will study a full wave bridge rectifier.

3.1 The full-wave bridge rectifier

Another type of circuit that produces the same output as a full-wave rectifier is that of the Bridge Rectifier (Figure 1). This type of single phase rectifier uses 4 individual rectifying diodes connected in a “bridged” configuration to produce the desired output but does not require a special center tapped transformer, thereby reducing its size and cost. The single secondary winding is connected to one side of the diode bridge network and the load to the other side as shown in figure. The 4 diodes labelled D_1 to D_4 are

arranged in “series pairs” with only two diodes conducting current during each half cycle. During the positive half cycle of the supply, diodes D_1 and D_2 conduct in series while diodes D_3 and D_4 are reverse biased and the current flows through the load as shown below (Figure 2). During the negative half cycle of the supply, diodes D_3 and D_4 conduct in series, but diodes D_1 and D_2 switch off as they are now reverse biased. The current flowing through the load is the same direction as before.

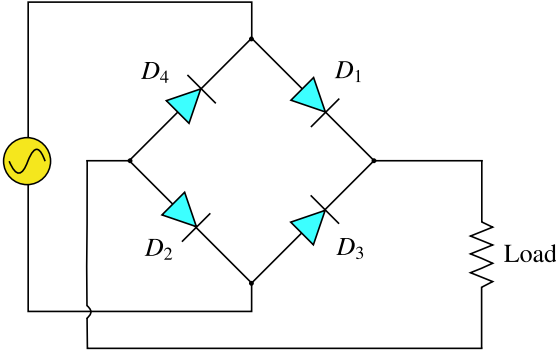


Figure 1: Full-wave bridge rectifier.

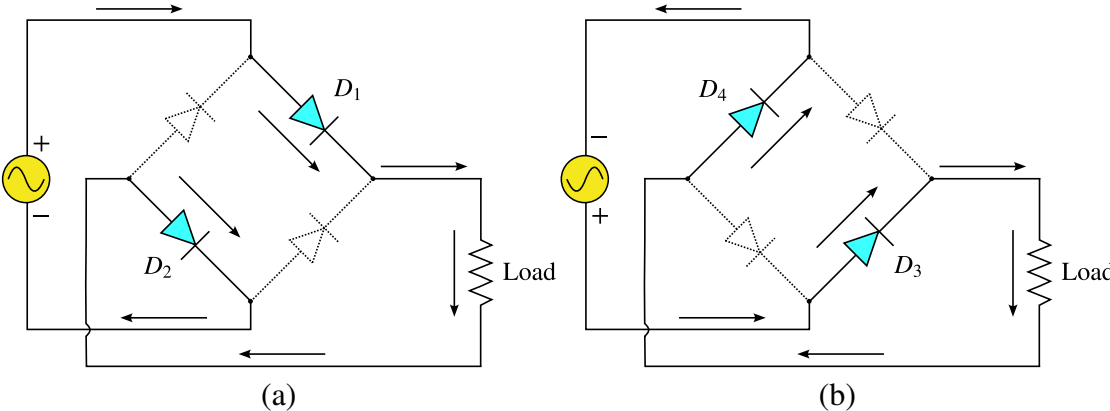


Figure 2: The working of a full-wave bridge rectifier. (a) Positive cycle. (b) Negative cycle.

As the current flowing through the load is unidirectional, so the voltage developed across the load is also unidirectional during both the half cycles. Thus, the average dc output voltage across the load resistor is double that of a half-wave rectifier circuit, assuming no losses.

$$V_{DC} = \frac{2V_{max}}{\pi} = 0.637V_{max}$$

3.2 Ripple factor

As mentioned in the previous lab the ripple factor is a measure of purity of the d.c. output of a rectifier and is defined as

$$V_{DC} = \frac{V_{AC}(\text{output})}{V_{DC}(\text{output})} = \sqrt{\frac{V_{\text{rms}}^2 - V_{DC}^2}{V_{DC}^2}} = \sqrt{\frac{V_{\text{rms}}^2}{V_{DC}^2} - 1} = \sqrt{\left(\frac{0.707}{0.637}\right)^2 - 1} = 0.48$$

In case of a full-wave rectifier $V_{\text{rms}} = V_{\text{max}}/\sqrt{2} = 0.707V_{\text{max}}$. The ripple frequency is now twice the supply frequency (eg. 100 Hz for a 50 Hz supply).

3.3 Rectification efficiency

Rectification efficiency η is given by

$$\begin{aligned} \eta &= \frac{\text{DC power delivered to load}}{\text{AC power at input}} \\ &= \frac{V_{DC}I_{DC}}{V_{AC}I_{AC}} \\ &= \frac{V_{DC}^2/R_L}{V_s^2/(r_d + R_L)} = \frac{(0.637V_{\text{max}})^2}{(0.707V_{\text{max}})^2 \left(1 + \frac{r_d}{R_L}\right)} = \frac{0.811}{\left(1 + \frac{r_d}{R_L}\right)} \end{aligned}$$

where r_d is the forward resistance of the diode. Under the assumption of no diode loss ($r_d \ll R_L$), the rectification efficiency in case of a full-wave rectifier is approximately 81.1%, which is twice the value for a half-wave rectifier.

3.4 Full-wave rectifier with capacitor filter

The full-wave rectifier circuit with capacitor filter is shown in Figure 3. The smoothing capacitor converts the full-wave rippled output of the rectifier into a smooth dc output voltage. The detailed description of its filtering action is already explained in half-wave rectifier handout. Two important parameters to consider when choosing a suitable capacitor are its *working voltage*, which must be higher than the no-load output value of the rectifier and its *capacitance value*, which determines the amount of ripple that will appear superimposed on top of the dc voltage.

Apart from rectification efficiency, the main advantages of a full-wave bridge rectifier is that it has a smaller ac ripple value for a given load and a smaller smoothing capacitor than an equivalent half-wave rectifier. The amount of ripple voltage that is superimposed on top of the dc supply voltage by the diodes can be virtually eliminated by adding other improved filters such as a pi-filter.

4 Circuit diagram

The circuit diagrams are as shown in Figures 1 and 3.

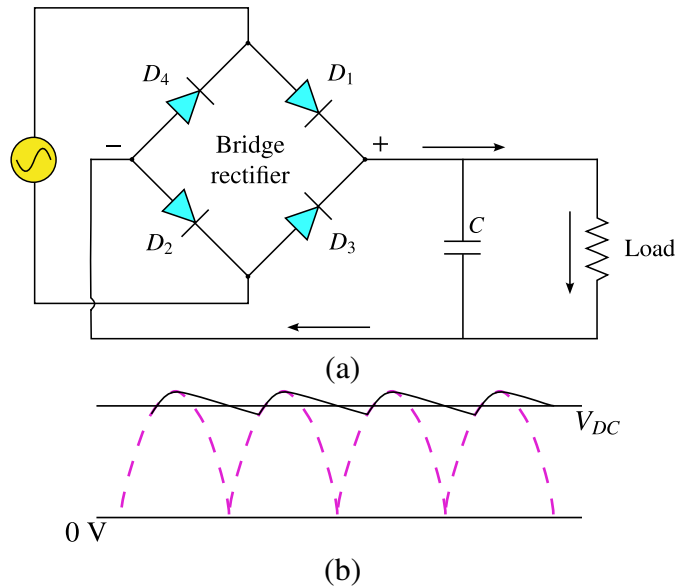


Figure 3: (a) A full-wave bridge rectifier with capacitor filter. (b) Output waveform.

5 Procedure

1. Configure the full-wave rectifier circuit as shown in the circuit diagram. Note down all the values of the components being used.
2. Connect the primary side of the transformer to the AC Mains and secondary to the input of the circuit.
3. Measure the input AC voltage (V_{AC}) and current (I_{AC}) and the output AC (V_{AC}) and DC (V_{DC}) voltages using multimeter for at least 3 values of load resistor (Be careful to choose proper settings of multimeter for AC and DC measurement).
4. Feed the input and output to the oscilloscope (we will use oscilloscope here only to trace the output waveform) and save the data for each measurement. **MEASURE THE INPUT AND OUTPUT VOLTAGES SEPARATELY.**
5. Multiply the V_{AC} at the input by 2 to get the peak value and calculate V_{DC} Using the formula $V_{DC} = 2V_{\max}/\pi$. Compare this value with the measured V_{DC} at the output.
6. Calculate the ripple factor and efficiency.
7. Connect the capacitor across the output for each load resistor. Measure the output AC and DC voltages once again and calculate the ripple factor. Trace the input and output waveforms in an oscilloscope and notice the change. (If time permits you could also use different values of capacitors and study the output)

6 Observations

1. Code number of diode = _____
2. Input Voltage: $V_{AC} =$ _____ V

Sl. No.	Load R_L (k Ω)	Input current I_{AC} (mA)	Output voltage			Ripple factor r	Efficiency $\eta = (V_{DC}^2/R_L)/(V_{AC}I_{AC})$ (%)
			V_{AC} (V)	V_{DC} (V)	$2V_{max}/\pi$ (V)		
1							
2							
3							

Table 1: Full-wave rectifier without filter.

Sl. No.	Load R_L (k Ω)	Output voltage		Ripple factor r
		V_{AC} (V)	V_{DC} (V)	
1				
2				
3				

Table 2: Full-wave rectifier with filter ($C =$ _____ μF).

6.1 Input and output waveforms

6.1.1 Waveforms without filter

$R_L =$ _____ k Ω

(Paste the pictures of your input and output waveforms here.)

6.1.2 Waveforms with filter

$R_L =$ _____ k Ω

(Paste the pictures of your input and output waveforms here.)

7 Results

8 Precautions