SUBJECT: BASIC ELECTRONICS

Full Wave Bridge Rectifier

Elementrix Classes

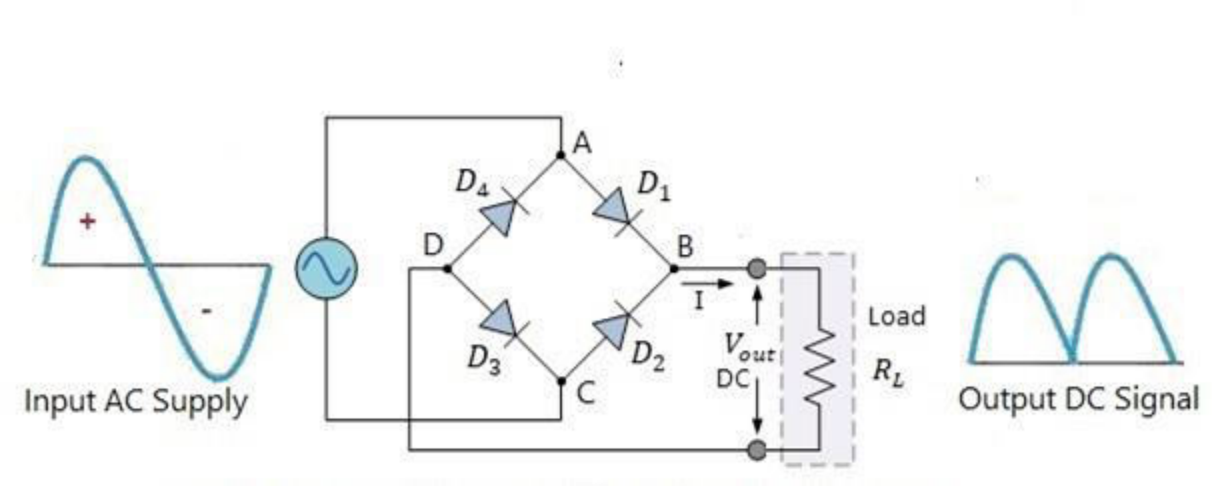
Full Wave Bridge Rectifier

- **Rectifier:** A rectifier is an electrical device that converts alternating current (AC), which periodically reverses direction, to direct current (DC), which flows in only one direction.

- **Need of Bridge Rectifier over Center Tapped:** The bridge rectifier is preferred over the center-tapped rectifier because it does not require a center-tapped transformer, making it more cost-effective and space-efficient. This design advantage, combined with similar efficiency, makes the bridge rectifier a popular choice in many practical applications.

Working

A bridge rectifier is a circuit that converts alternating current (AC) to direct current (DC). It utilizes four diodes arranged in a bridge configuration to rectify the AC input. The working of a bridge rectifier can be understood through the following steps:



- **AC Input:**

  The bridge rectifier is connected to an AC power source.

  During the positive half-cycle of the AC waveform, one pair of diodes (D_1 and D_3) becomes forward-biased, allowing current to flow through the load in one direction. The other pair of diodes (D_2 and D_4) is reverse-biased and blocks the current flow.

- **Bridge Configuration:**

  As the AC waveform changes direction (negative half-cycle), the roles of the diodes switch. Now, diodes D_2 and D_4 become forward-biased, and D_1 and D_3 become reverse-biased. This arrangement ensures that current always flows in the same direction through the load.

- **Output Voltage:**

  The output across the load is the rectified DC voltage. The bridge rectifier provides a continuous DC output, effectively utilizing both halves of the AC waveform.

- **Waveform Shape:**

  The resulting waveform has less ripple compared to a half-wave rectifier because it rectifies both halves of the AC cycle.

For an AC voltage given the waveform of the output voltage of a full wave rectifier can be written as (for an ideal diode)

$$V_o(t) = \begin{cases} V_m \sin(\omega t), & 0 \leq t \leq T/2 \\ V_m \sin(\omega t - \pi), & T/2 \leq t \leq T \end{cases}$$

Full Wave Bridge Rectifier Calculations

- **Average output voltage (V_{dc}):** This represents the average value of the rectified DC voltage over a full cycle. For a full wave rectifier,

$$V_{dc} = \frac{2V_m}{\pi}$$

- **Root mean square (RMS) output voltage (V_{rms}):** This refers to the effective value of the AC component remaining in the DC output. For a full wave rectifier,

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

- **Ripple Factor (γ):** Ripple is the unwanted AC component remaining when converting the AC voltage waveform into a DC waveform. Even though we try out best to remove all AC components,there is still some small amount left on the output side which pulsates the DC waveform. This undesirable AC component is called ripple.

  This measures the AC variation present in the DC output, indicating its smoothness. It's calculated as

$$\gamma = \sqrt{\left(\frac{V_{rms}}{V_{dc}}\right)^2 - 1}$$

- **Efficiency:** The ratio of the DC power available at the load to the applied input AC power is known as the efficiency, **η**. Mathematically it can be given as:

$$\eta = \frac{DC\,power\,output}{AC\,power\,input} = \frac{P_{dc}}{P_{ac}} = 81.2\%$$

- **Form factor:** Form factor (f.f.) is defined as the ratio between RMS load voltage and average load voltage. The form factor of the full wave rectifier is as,

$$f.f. = \frac{V_{rms}}{V_{dc}}$$

- **Peak inverse voltage (PIV):** Peak Inverse Voltage (PIV) is the maximum voltage that the diode can withstand during reverse bias condition. If a voltage is applied more than the PIV, the diode will be destroyed.Thus for a full wave bridge rectifier,

$$PIV = V_m$$

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