Analog Electronics

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1st **semester**

Chapter Two
Diode and its Application

Lecture 5

Full wave rectifiers

Although half-wave rectifiers have some applications, the full-wave rectifier is the most commonly used type in **DC power supplies**.

A full-wave rectifier **allows** unidirectional (one-way) current through the load during the entire of the input cycle.

Whereas a **half-wave rectifier** allows current through the load only during one-half of the cycle.

The output voltage have twice the input frequency.

$V_{AVG} = \mathbf{2V_P/\pi} = V_{AVG}$ is approximately 63.7 % of Vp

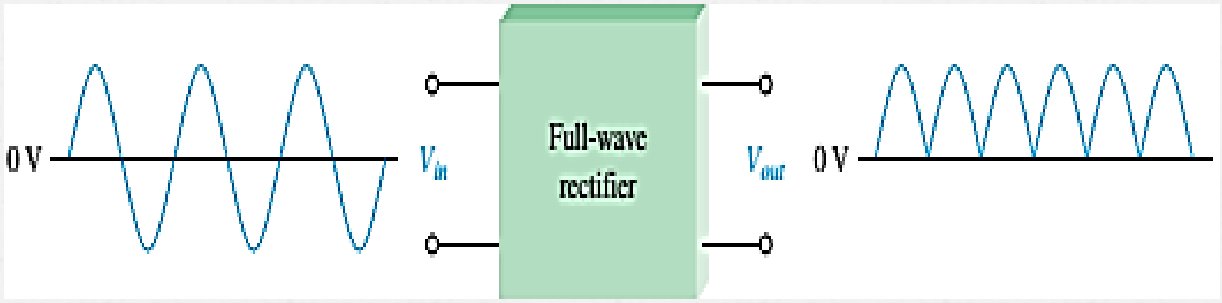
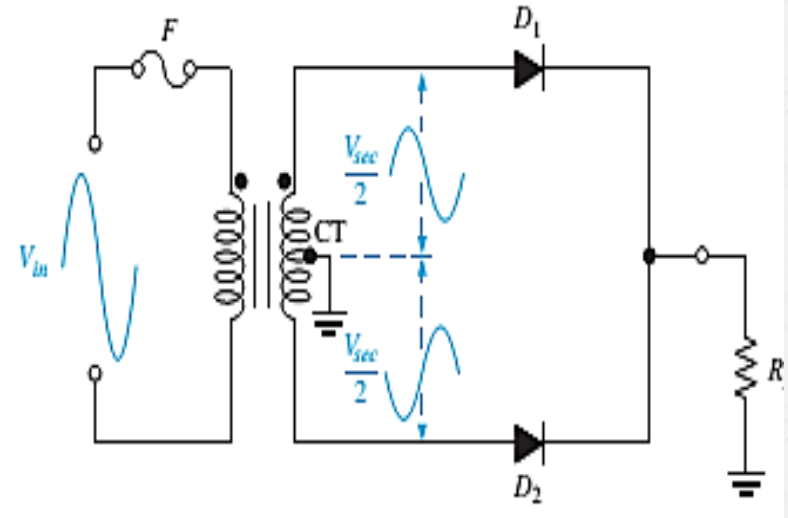
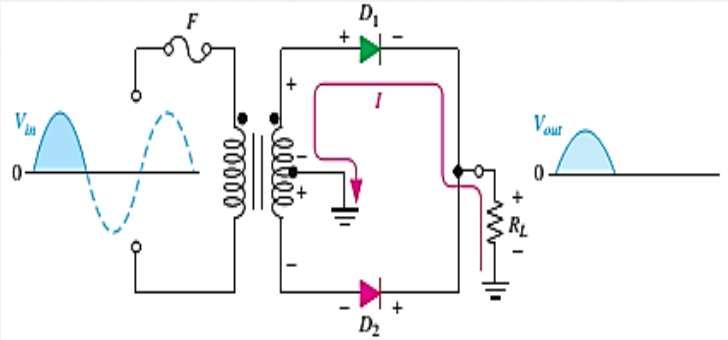


Figure 14

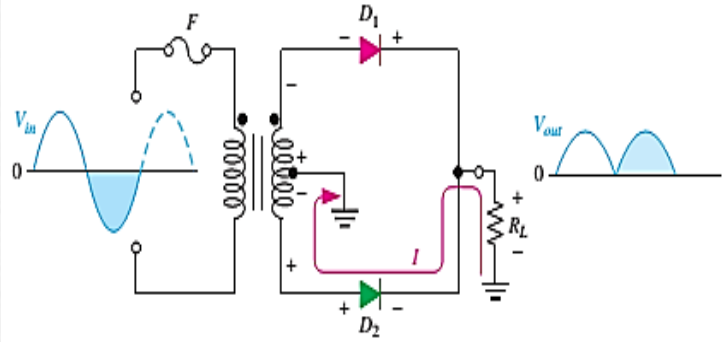
Center-Tapped Full-Wave Rectifier Operation

A **center-tapped rectifier** uses **two diodes connected** to the secondary of a **center-tapped transformer**, as shown in Figure 1.





(a) During positive half-cycles, D_1 is forward-biased and D_2 is reverse-biased.

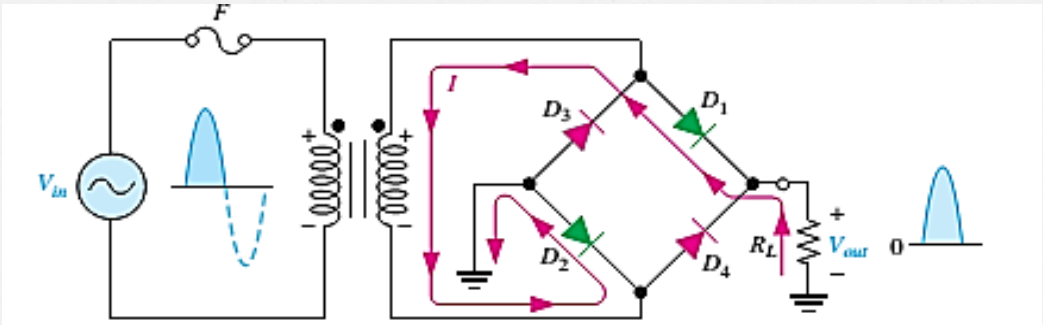


(b) During negative half-cycles, D_2 is forward-biased and D_1 is reverse-biased.

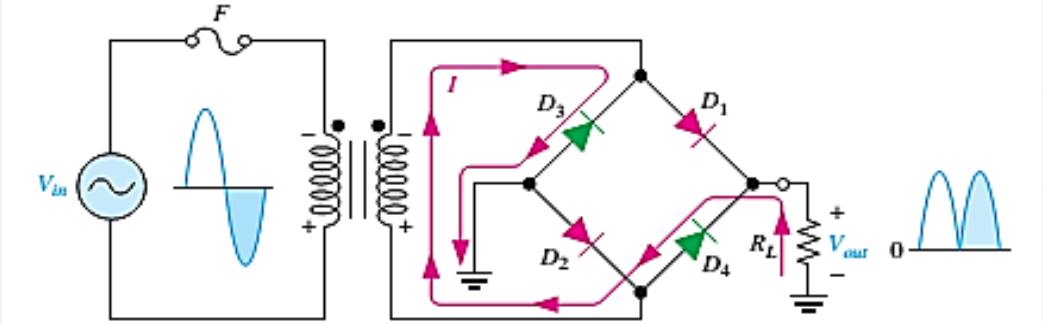
Figure 1: Basic operation of a center-tapped full-wave rectifier.

The Bridge Full-wave rectifiers

The Bridge Full-Wave rectifier uses **four diodes** connected across the entire secondary, as shown in Figure below.



(a) During the positive half-cycle of the input, D_1 and D_2 are forward-biased and conduct current. D_3 and D_4 are reverse-biased.



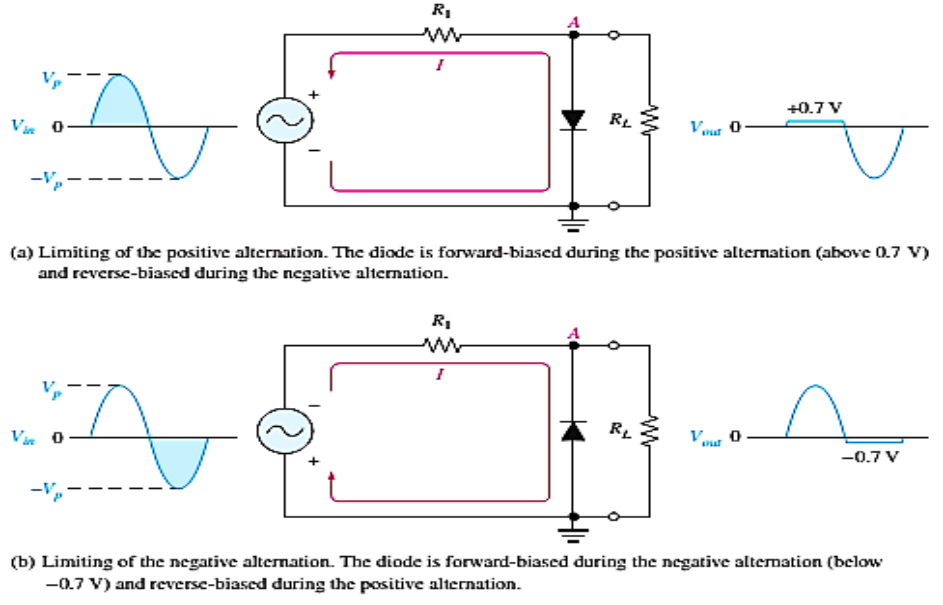
(b) During the negative half-cycle of the input, D_3 and D_4 are forward-biased and conduct current. D_1 and D_2 are reverse-biased.

Diode Limiters

Diode circuits, called **limiters or clippers**, are used to **clip off portions of signal voltages above** or **below certain levels**.

Point A is limited to +0.7V when the input voltage exceeds this value (Figure 3(a)).

If the diode is **turned around**, as in Figure 3(b), the negative part of the input voltage is clipped off. When the diode is forward-biased during the negative part of the input voltage, **point A** is held at -0.7V by the diode drop.



(a) Limiting of the positive alternation. The diode is forward-biased during the positive alternation (above 0.7 V) and reverse-biased during the negative alternation.

(b) Limiting of the negative alternation. The diode is forward-biased during the negative alternation (below −0.7 V) and reverse-biased during the positive alternation.

Figure 3: Examples of diode limiters (clippers).

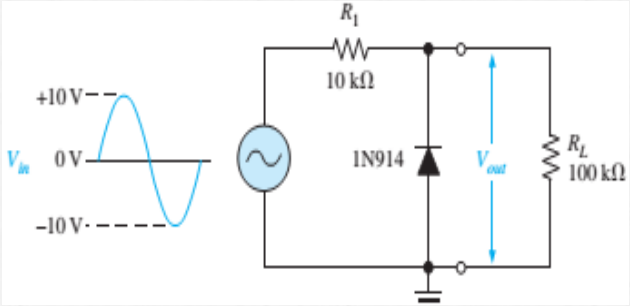
A **power supply** or **voltage divider** can attain the desired amount of **limitation.**

The **amount clipped** can be adjusted with different levels of $\mathbf{V_{BIAS}}$.

The peak output voltage across $\mathbf{R_L}$ is determined by the following equation:

$$V_{out} = \left(\frac{R_L}{R_1 + R_L}\right) V_{in}$$

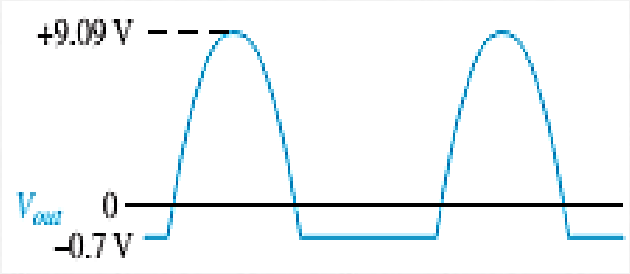
Example 2: What would you expect to see displayed on an oscilloscope connected across R_L in the limiter shown in the following Figure/



Solution: The diode is forward-biased and conducts when the input voltage goes below -0.7V. So, for the negative limiter, determine the peak output voltage across R_L by.

$$= \left(\frac{R_L}{R_1 + R_L}\right) V_{in} = \left(\frac{100\text{k}\Omega}{110\text{k}\Omega}\right) 10\text{V} = 9.09\text{V}$$

The scope will display an output waveform as shown in following Figure

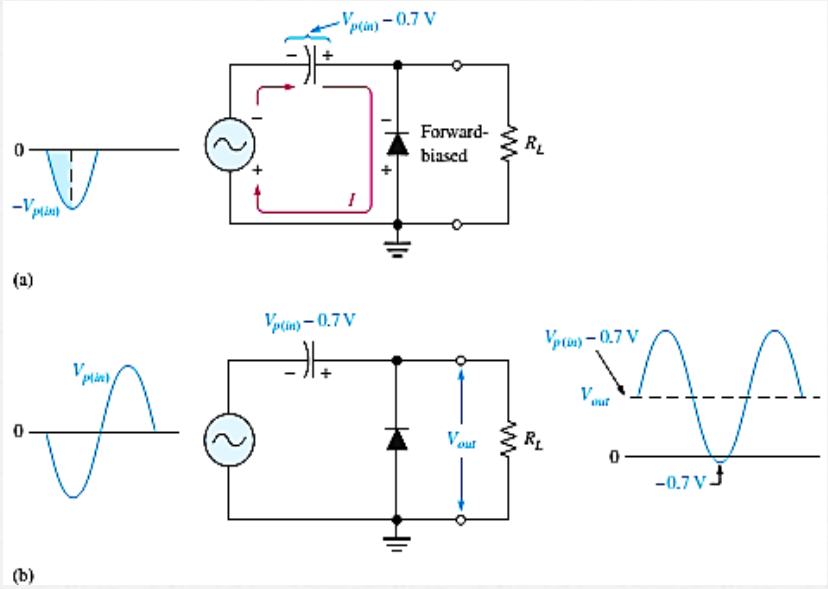


Diode Clampers

Another type of diode circuit, called **a clamper**, is used to **add or restore a dc level to an electrical signal**.

The **capacitor charges to the peak of the supply minus the diode drop**. **Once charged the capacitor acts like a battery** in series with the input voltage.

The **AC voltage** will "ride" along with the DC voltage. The polarity arrangement of the diode determines whether the DC voltage is negative or positive.



Voltage Multiplier

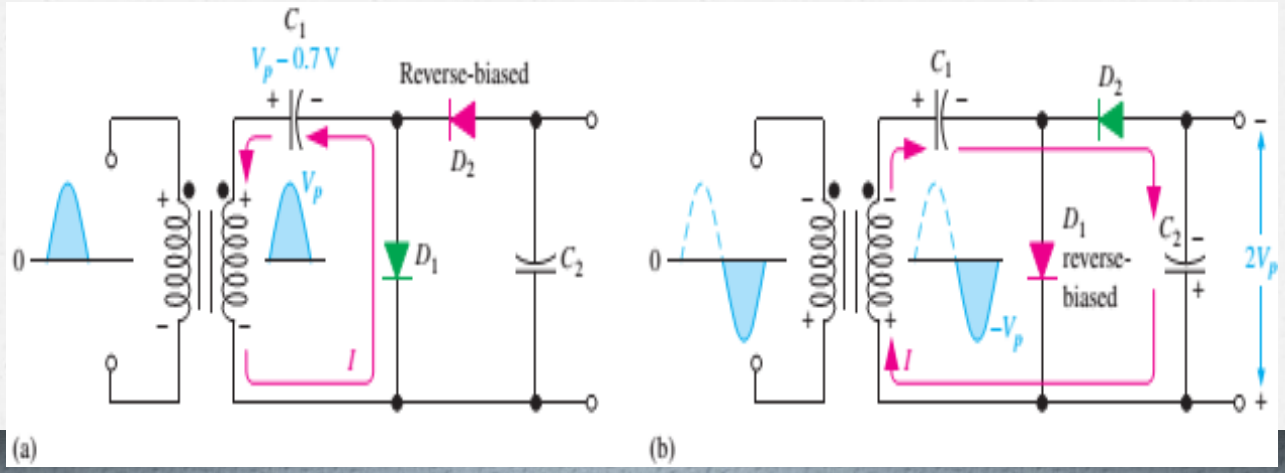
Voltage multipliers use **clamping action** to increase peak rectified voltages **without the necessity of increasing the transformer's voltage rating**.

Multiplication factors of two, three, and four are common. Voltage multipliers are **used** in high-voltage, low-current applications such as cathode-ray tubes (CRTs) and particle accelerators.

In the Figure below, a **half-wave voltage doubler**, voltage doubler is a voltage multiplier with a multiplication factor of two.

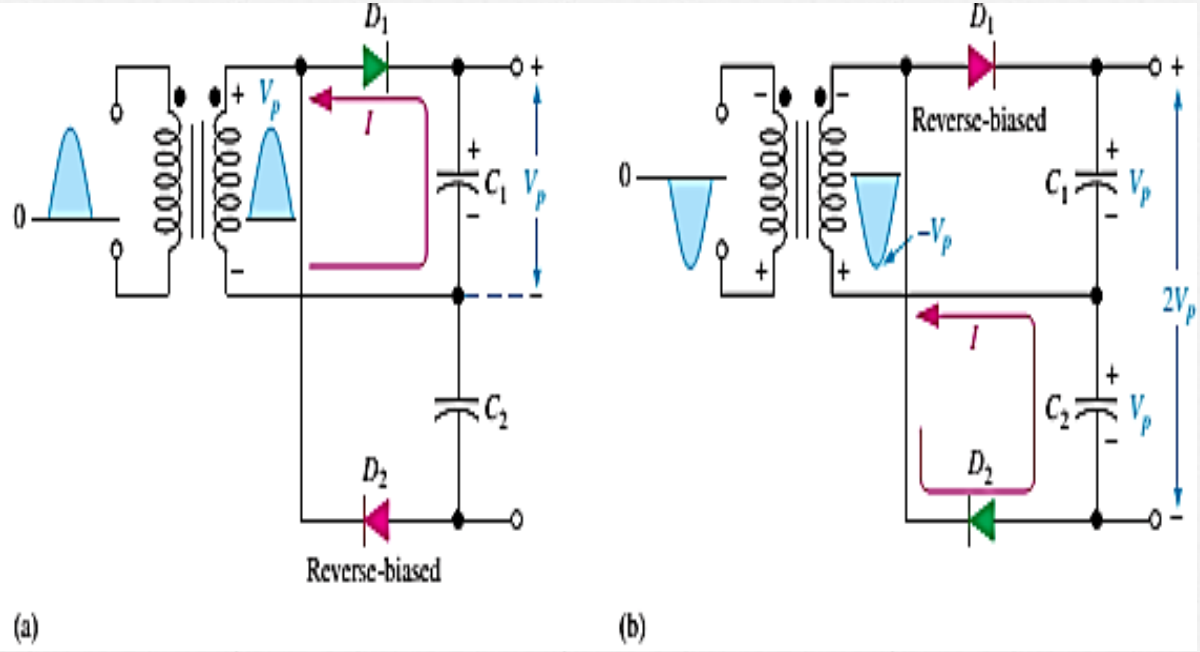
Once C1 and C2 charge to the peak voltage, it acts **like two batteries** in series, effectively doubling the voltage output.

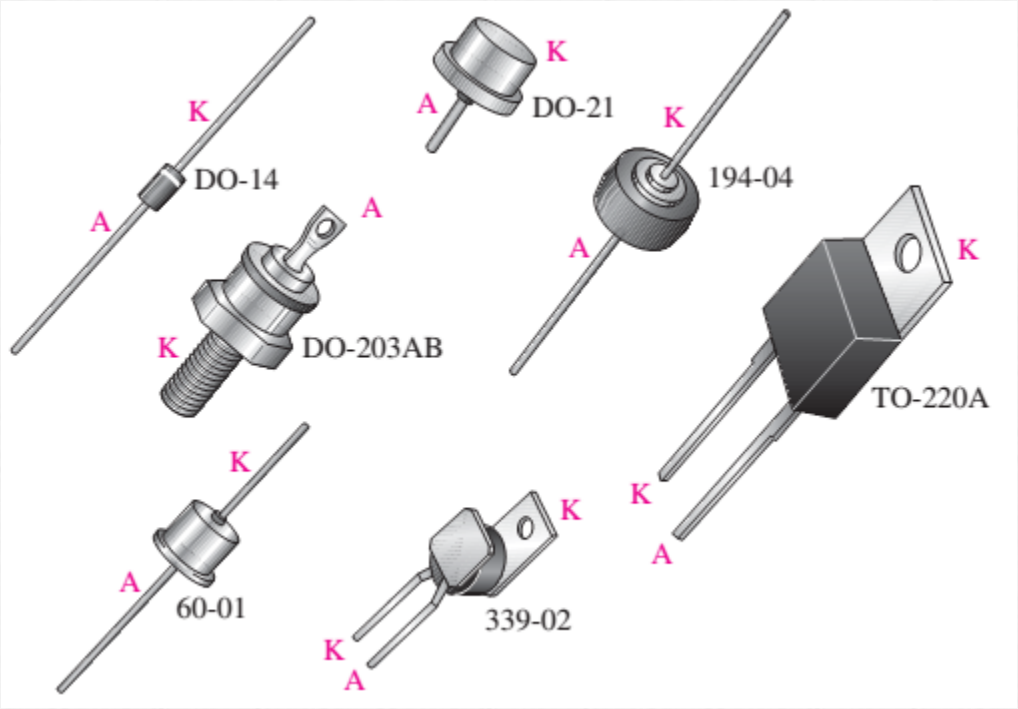
The **current capacity** for voltage multipliers is **low**.



The full-wave voltage doubler arrangement of diodes and capacitors takes advantage of positive and negative peaks to charge the capacitors, giving them more current capacity.

Voltage triplers and **quadruplers** utilize three and four-diode-capacitor arrangements, respectively.





Typical diode packages with terminal identification. The letter K is used for cathode to avoid confusion with certain electrical quantities that are represented by C. Case type numbers are indicated for each diode.