Power Supply Filters

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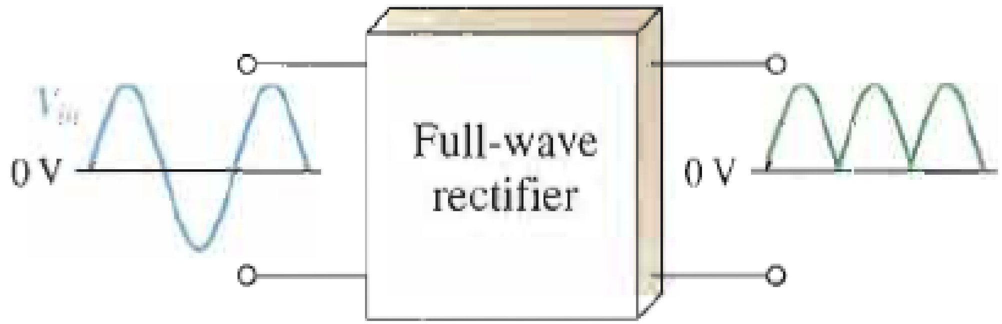
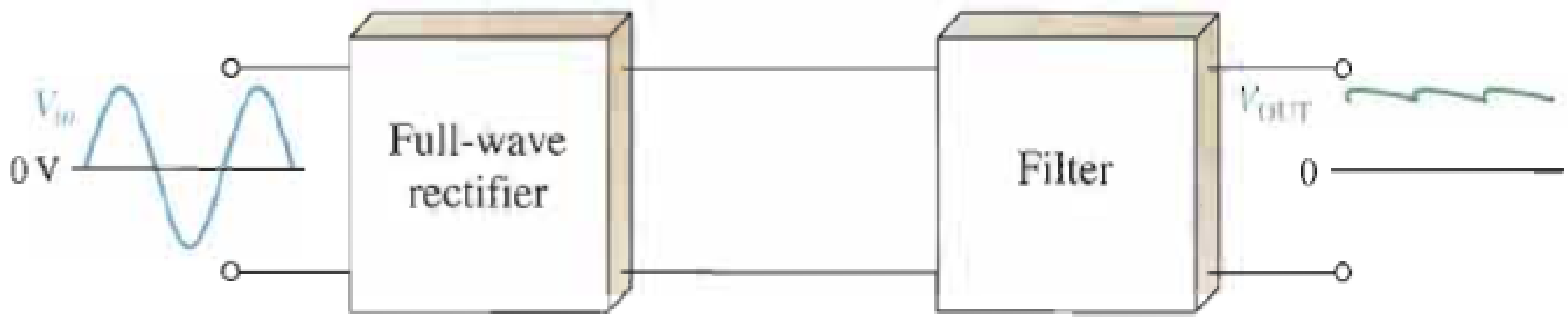
FILTER Section OF THE Power Supply

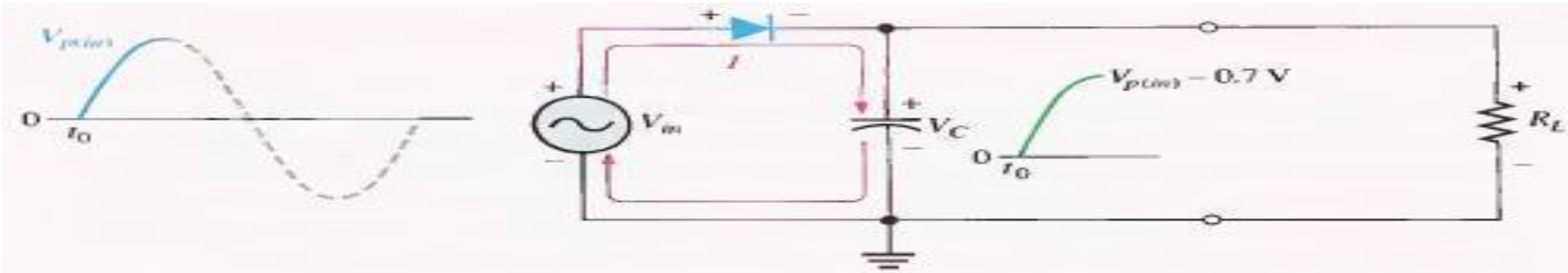


(a) Rectifier without a filter

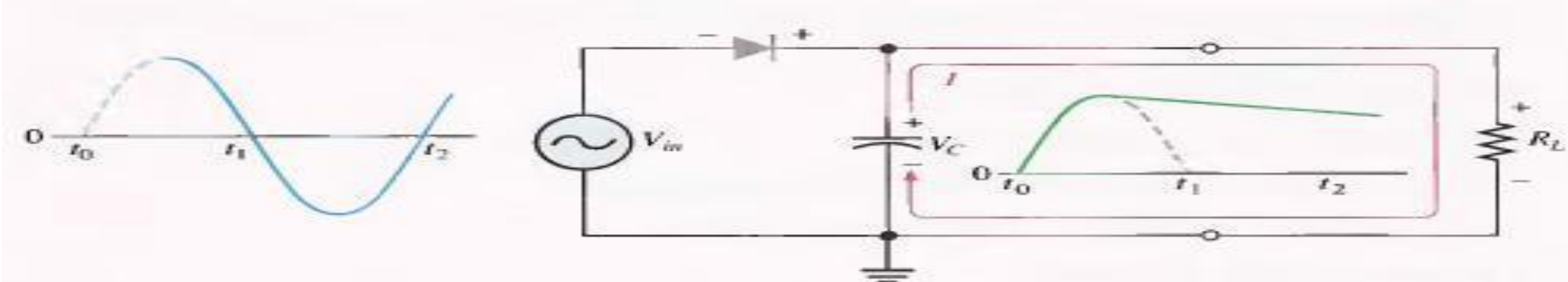


(b) Rectifier with a filter (output ripple is exaggerated)

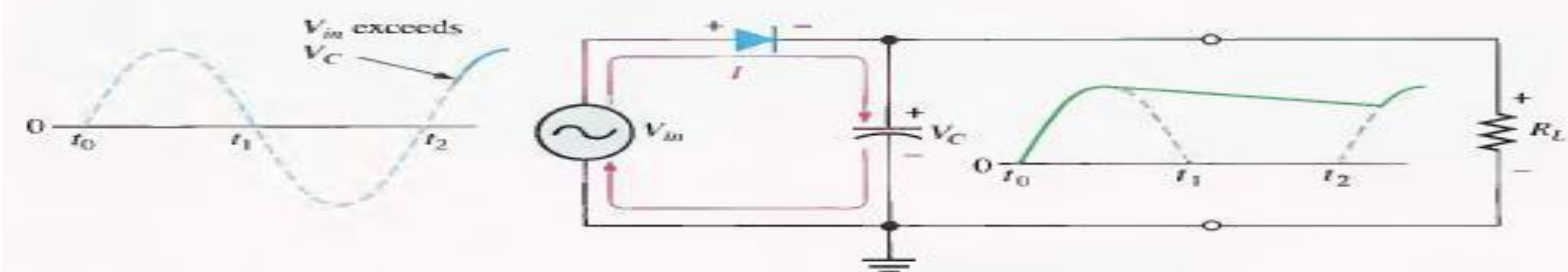
Capacitor Input Filter:



(a) Initial charging of the capacitor (diode is forward-biased) happens only once when power is turned on.



(b) The capacitor discharges through R_L after peak of positive alternation when the diode is reverse-biased. This discharging occurs during the portion of the input voltage indicated by the solid blue curve.

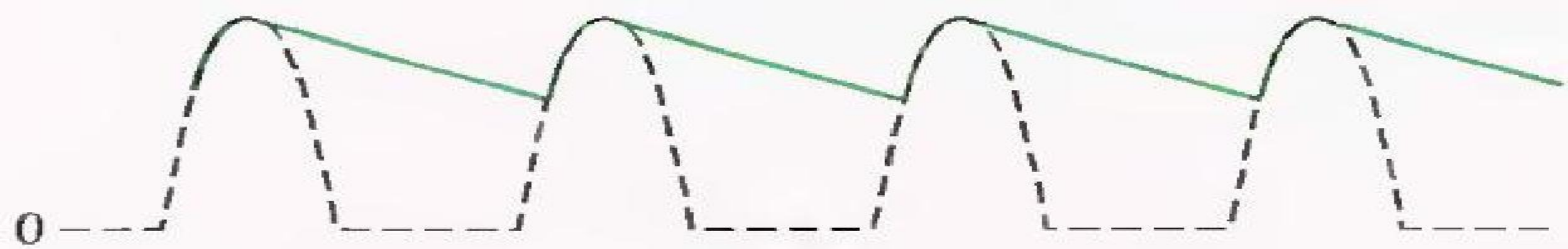


(c) The capacitor charges back to peak of input when the diode becomes forward-biased. This charging occurs during the portion of the input voltage indicated by the solid blue curve.

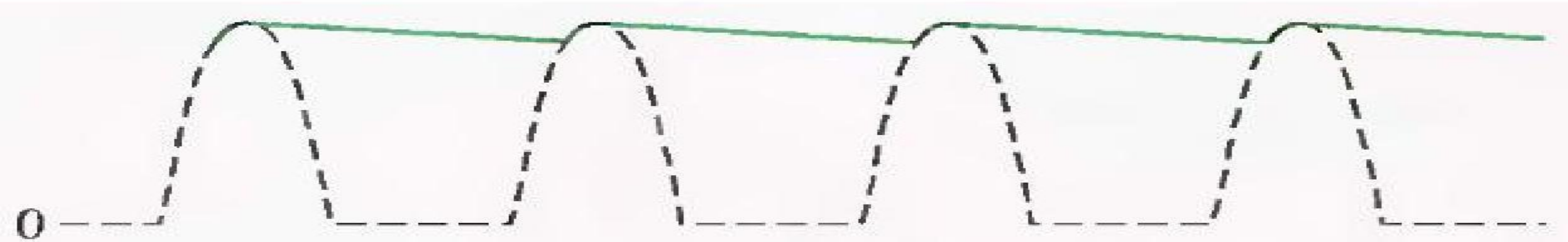
- The filter can simply a capacitor connected from the rectifier output to ground.

Ripple Voltage as a measure of the Filter Effectiveness:

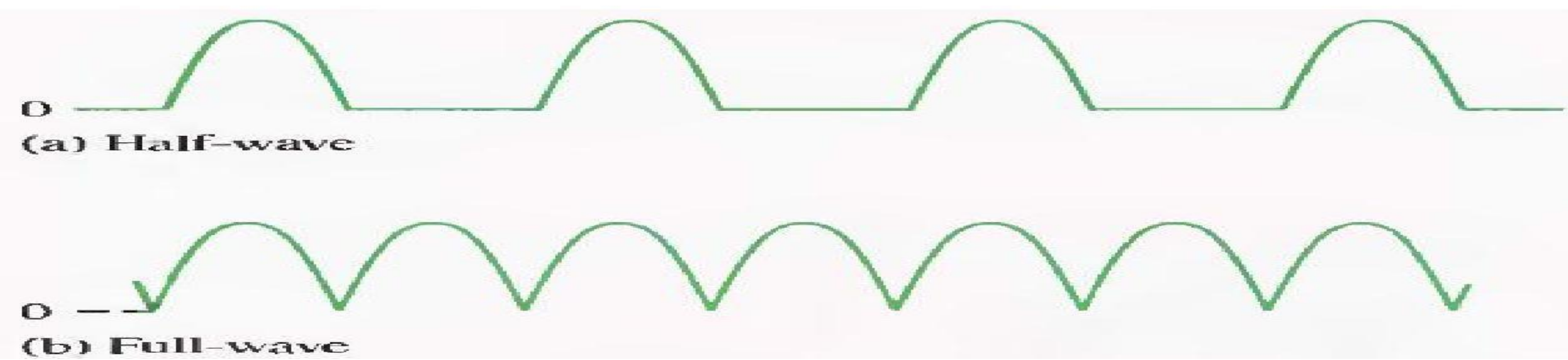
- The variation in the capacitor voltage due to charging and discharging is called the **Ripple Voltage**.

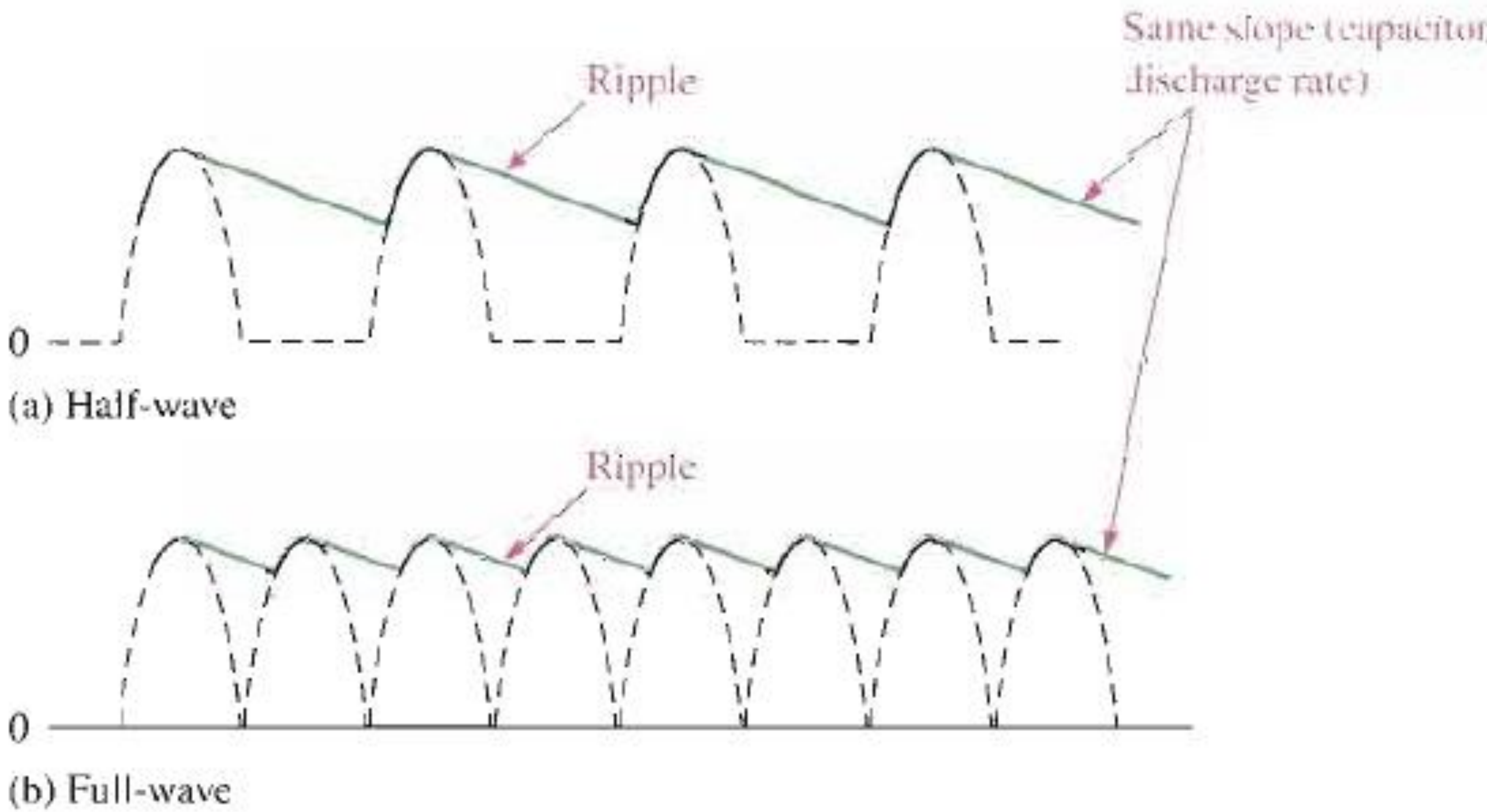


(a) Larger ripple means less effective filtering.



(b) Smaller ripple means more effective filtering. Generally, the larger the capacitor value, the smaller the ripple for the same input and load.



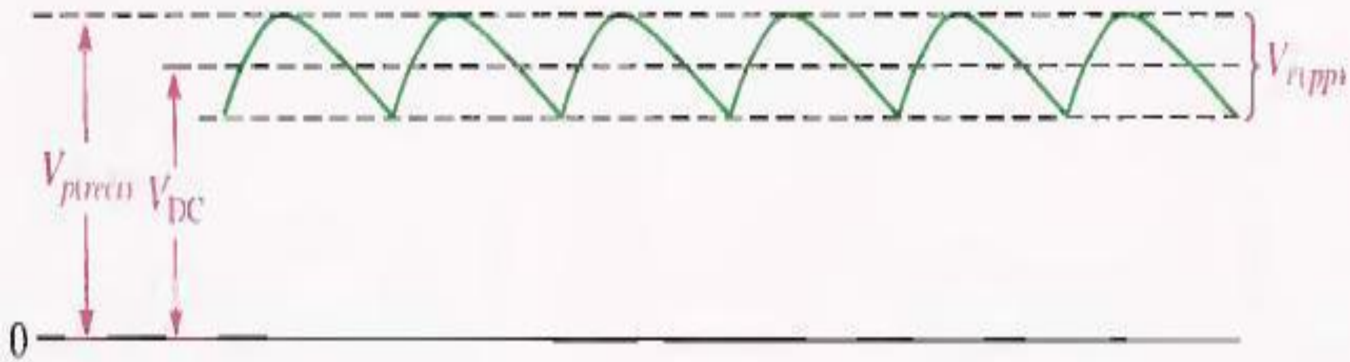


Comparison of ripple voltages for half-wave and full-wave rectified voltages with the same filter capacitor and load and derived from the same sinusoidal input voltage.

Ripple Factor The **ripple factor** (***r***) is an indication of the effectiveness of the filter and is defined as

$$r = \frac{V_{r(pp)}}{V_{DC}}$$

where $V_{r(pp)}$ is the peak-to-peak ripple voltage and V_{DC} is the dc (average) value of the filter's output voltage, as illustrated in Figure 2–29. The lower the ripple factor, the better the filter. The ripple factor can be lowered by increasing the value of the filter capacitor or increasing the load resistance.

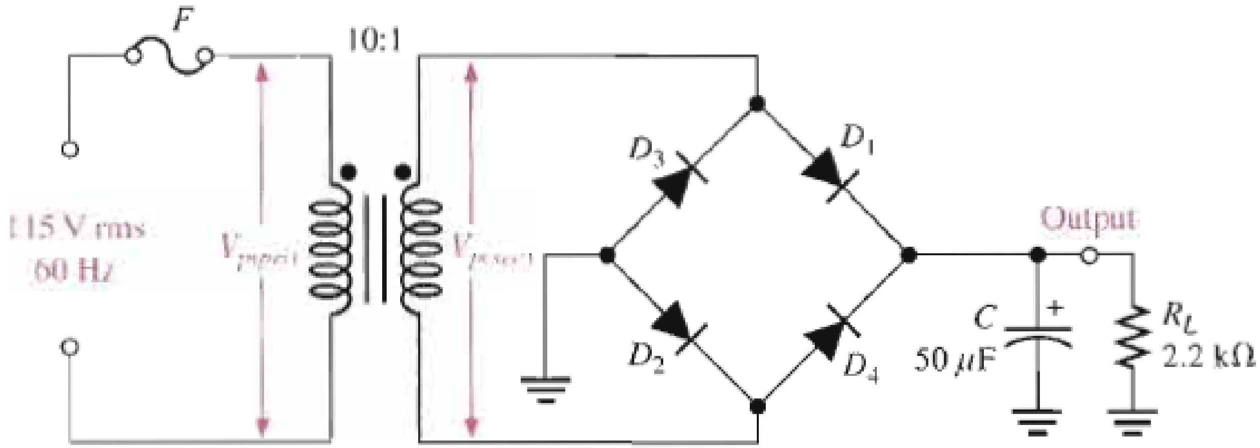


For a full-wave rectifier with a capacitor-input filter, approximations for the peak-to-peak ripple voltage, $V_{r(pp)}$, and the dc value of the filter output voltage, V_{DC}, are given in the following expressions. The variable $V_{p(rect)}$ is the unfiltered peak rectified voltage.

$$V_{r(pp)} \cong \left(\frac{1}{fR_LC}\right)V_{p(rect)}$$

$$V_{DC} \cong \left(1 - \frac{1}{2fR_LC}\right)V_{p(rect)}$$

Example: Determine the ripple factor for the filtered bridge rectifier with a load as indicated in figure below.



All diodes are 1N4001.

Solution The transformer turns ratio is $n = 0.1$. The peak primary voltage is

$$V_{p(pri)} = 1.414V_{rms} = 1.414(115\text{ V}) = 163\text{ V}$$

The peak secondary voltage is

$$V_{p(sec)} = nV_{p(pri)} = 0.1(163\text{ V}) = 16.3\text{ V}$$

The unfiltered peak full-wave rectified voltage is

$$V_{p(rect)} = V_{p(sec)} - 1.4\text{ V} = 16.3\text{ V} - 1.4\text{ V} = 14.9\text{ V}$$

The frequency of a full-wave rectified voltage is 120 Hz. The approximate peak-to-peak ripple voltage at the output is

$$V_{r(pp)} \cong \left(\frac{1}{fR_LC}\right)V_{p(rect)} = \left(\frac{1}{(120\text{ Hz})(2.2\text{ k}\Omega)(50\ \mu\text{F})}\right)14.9\text{ V} = 1.13\text{ V}$$

The approximate dc value of the output voltage is determined as follows:

$$V_{DC} = \left(1 - \frac{1}{2fR_LC}\right)V_{p(rect)} = \left(1 - \frac{1}{(240\text{ Hz})(2.2\text{ k}\Omega)(50\ \mu\text{F})}\right)14.9\text{ V} = 14.3\text{ V}$$

The resulting ripple factor is

$$r = \frac{V_{r(pp)}}{V_{DC}} = \frac{1.13\text{ V}}{14.3\text{ V}} = \mathbf{0.079}$$

The percent ripple is 7.9%.