3. What causes the ripple voltage on the output of a capacitor-input filter?
4. If the load resistance connected to a filtered power supply is decreased, what happens to the ripple voltage?
5. Define *ripple factor.*
6. What is the difference between input (line) regulation and load regulation?

2–7 DIODE LIMITERS AND CLAMPERS

Diode circuits, called limiters or clippers, are sometimes used to clip off portions of signal voltages above or below certain levels. Another type of diode circuit, called a clamper, is used to add or restore a dc level to an electrical signal. Both limiter and clamper diode circuits will be examined in this section.

After completing this section, you should be able to

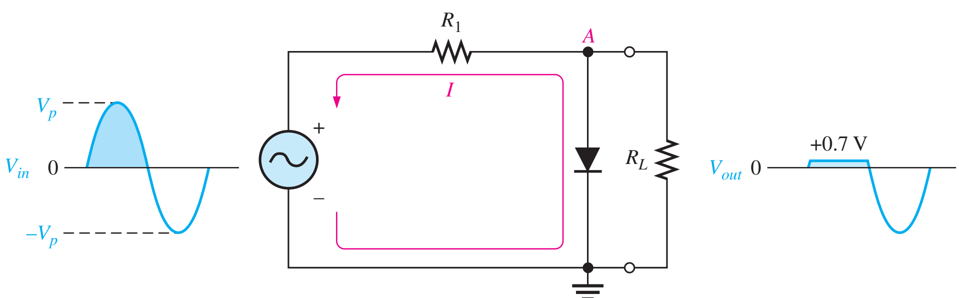
- **Explain and analyze the operation of diode limiters and clampers**
- Describe the operation of a diode limiter
  ◆ Discuss biased limiters ◆ Discuss voltage-divider bias ◆ Describe an application
- Describe the operation of a diode clamper

Diode Limiters

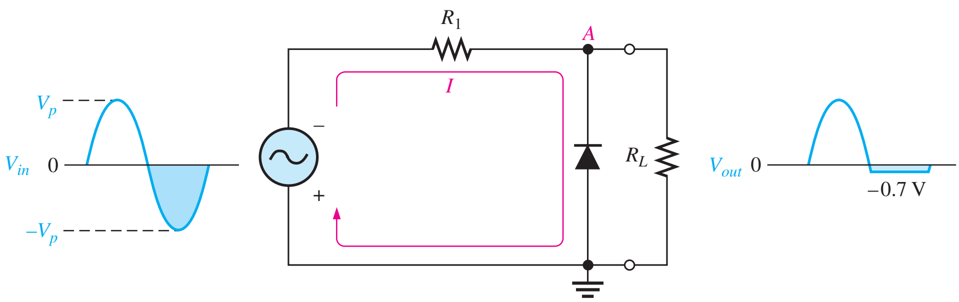
Figure 2–52(a) shows a diode positive **limiter** (also called **clipper**) that limits or clips the positive part of the input voltage. As the input voltage goes positive, the diode becomes forward-biased and conducts current. Point *A* is limited to +0.7 V when the input voltage exceeds this

▶ FIGURE 2–52

Examples of diode limiters (clippers).



(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.

value. When the input voltage goes back below 0.7 V, the diode is reverse-biased and appears as an open. The output voltage looks like the negative part of the input voltage, but with a magnitude determined by the voltage divider formed by R_1 and the load resistor, R_L, as follows:

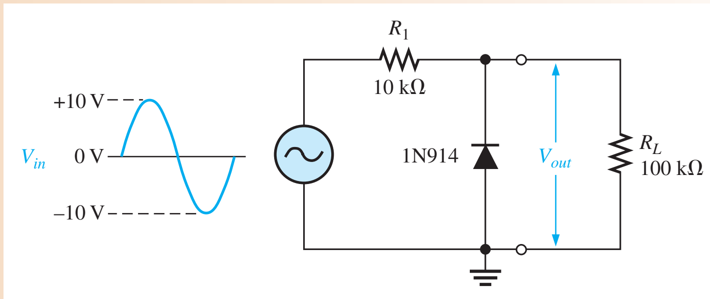
$$V_{out} = \left(\frac{R_L}{R_1 + R_L}\right)V_{in}$$

If R_1 is small compared to R_L, then $V_{out} \cong V_{in}$.

If the diode is turned around, as in Figure 2–52(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 -0.7 V by the diode drop. When the input voltage goes above -0.7 V, the diode is no longer forward-biased; and a voltage appears across R_L proportional to the input voltage.

EXAMPLE 2–10

What would you expect to see displayed on an oscilloscope connected across R_L in the limiter shown in Figure 2–53?

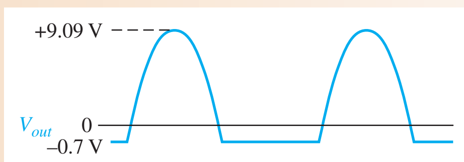


▶ FIGURE 2–53

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

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

The scope will display an output waveform as shown in Figure 2–54.



▶ FIGURE 2–54

Output voltage waveform for Figure 2–53.

Related Problem Describe the output waveform for Figure 2–53 if R_1 is changed to 1 kΩ.

Open the Multisim file E02-10 in the Examples folder on the companion website. For the specified input, measure the resulting output waveform. Compare with the waveform shown in the example.