DC Resistance versus Bulk Resistance

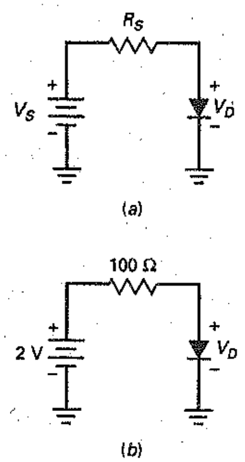
The dc resistance of a diode is different from the bulk resistance. The dc resistance of a diode equals the bulk resistance *plus* the effect of the barrier potential. In other words, the dc resistance of a diode is its total resistance, whereas the bulk resistance is the resistance of only the p and n regions. For this reason, the dc resistance of a diode is always greater than bulk resistance.

3-10 Load Lines

This section is about the **load line,** a tool used to find the exact value of diode current and voltage. Load lines are useful with transistors, so a detailed explanation will be given later in the transistor discussions.

Equation for the Load Line

Figure 3-17 Load-line analysis.



How can we find the exact diode current and voltage in Fig. 3-17*a*? The current through the resistor is:

$$I_D = \frac{V_S - V_D}{R_s} \tag{3-8}$$

Because of the series circuit, this current is the same through the diode.

An Example

If the source voltage is 2 V and the resistance is 100 Ω as shown in Fig. 3-17*b*, then Eq. (3-8) becomes:

$$I_D = \frac{2 - V_D}{100} \tag{3-9}$$

Equation (3-9) is a linear relationship between current and voltage. If we plot this equation, we will get a straight line. For instance, let V_D equal zero. Then:

$$I_D = \frac{2\text{ V} - 0\text{ V}}{100\ \Omega} = 20\text{ mA}$$

Plotting this point (I_D = 20 mA, V_D = 0) gives the point on the vertical axis of Fig. 3-18. This point is called *saturation* because it represents maximum current with 2 V across 100 Ω.

Here's how to get another point. Let V_D equal 2 V. Then Eq. (3-9) gives:

$$I_D = \frac{2\text{ V} - 2\text{ V}}{100\ \Omega} = 0$$

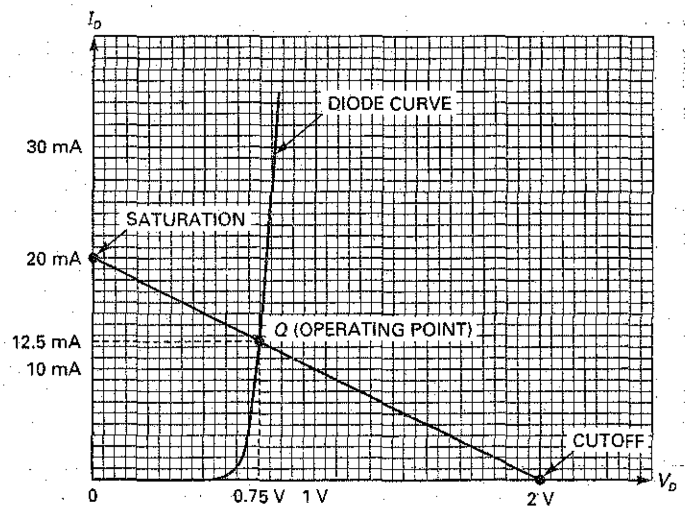
When we plot this point (I_D = 0, V_D = 2 V), we get the point shown on the horizontal axis (Fig. 3-18). This point is called *cutoff* because it represents minimum current.

By selecting other voltages, we can calculate and plot additional points. Because Eq. (3-9) is linear, all points will lie on the straight line shown in Fig. 3-18. The straight line is called the *load line.*

The Q Point

Figure 3-18 shows the load line and a diode curve. The point of intersection, known as the Q point, represents a simultaneous solution between the diode curve and the load line. In other words, the Q point is the only point on the graph that works for both the diode and the circuit. By reading the coordinates of the Q point, we get a current of 12.5 mA and a diode voltage of 0.75 V.

Figure 3-18 *Q* point is the intersection of the diode curve and the load line.



Incidentally, the Q point has no relationship to the figure of merit of a coil. In the present discussion, Q is an abbreviation for *quiescent*, which means "at rest." The quiescent or Q point of semiconductor circuits is discussed in later chapters.

3-11 Surface-Mount Diodes

Surface-mount (SM) diodes can be found anywhere there is a need for diode applications. SM diodes are small, efficient, and relatively easy to test, remove, and replace on the circuit board. Although there are a number of SM package styles, two basic styles dominate the industry: SM (surface mount) and SOT (small outline transistor).

The SM package has two L-bend leads and a colored band on one end of the body to indicate the cathode lead. Figure 3-19 shows a typical set of dimensions. The length and width of the SM package are related to the current rating of

Figure 3-19 The two-terminal SM-style package, used for SM diodes.