3–7 Karnaugh map simplification

The simplification of logic equations using the laws of Boolean algebra requires that one be proficient in applying these laws appropriately to obtain an equivalent logic equation in its simplest form. In many cases, Boolean simplification must be performed on a trial-and-error basis and consequently can be quite time-consuming. The *Karnaugh map* (K-map) simplification technique is a more direct and mechanical technique that (if used properly) can obtain the simplest logic equation from the truth table of an unsimplified logic equation. Furthermore, the K-map can also be used to obtained simplified logic equations in both sum-of-products and product-of-sums form using the same procedures.

The Karnaugh map, also referred to as a *K-map*, is a modified version of a truth table. Like a truth table, it maps the dependent variable as a function of the independent variables, but its arrangement is such that we can tell by inspection if simplification is possible or not, and if simplification is possible its configuration allows us to obtain the simplest possible logic equation. K-maps are generally classified according to the number of independent variables in the logic equation, circuit, or truth table. We generally deal with two-variable, three-variable, and four-variable K-maps. K-maps with more than four variables are possible but can get very complicated and therefore other techniques must be used. This section will examine the configuration of these K-maps and their use in the simplification of logic equations. This technique will be used in the simplification of logic equations for most of the examples covered in the rest of this book and therefore it is important that its usage be thoroughly understood.

Two-variable Karnaugh maps

The general configuration of a two-variable K-map is shown in Figure 3–43 to represent the independent variables A and B and the dependent variable X. The K-map is made up of four *cells* (corresponding to the four combinations of two independent variables, $2^2 = 4$). For reference purposes only, each cell has been numbered from 0 to 3 to identify the binary combination of A and B that identifies the cell (assuming that A is the MSB and B is the LSB). Therefore cell no. 0 corresponds to $A = 0$ and $B = 0$, and cell no. 1 corresponds to $A = 0$ and $B = 1$, cell no. 2 corresponds to $A = 1$ and $B = 0$, and cell no. 3 corresponds to $A = 1$ and $B = 1$. The bits that will be placed in each cell will be the values of the dependent variable X. For example, Figure 3–44 shows a two-variable truth table and its corresponding K-map configuration. Notice in Figure

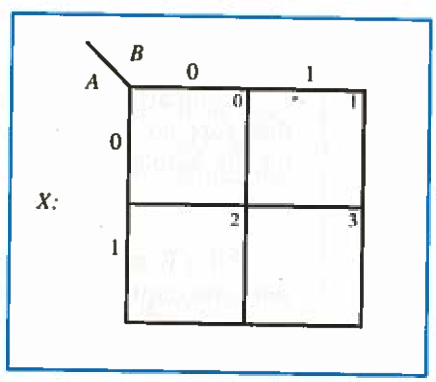

Figure 3–43
General configuration of a two-variable K-map.