



## Experiment 8 Logic Circuit Simplification

### Objectives

After completing this experiment, you will be able to

- Develop the truth table for a BCD invalid code detector.
- Use a Karnaugh map to simplify the expression.
- Build and test a circuit that implements the simplified expression.
- Predict the effect of "faults" in the circuit.

### Materials Needed

7400 NAND gate  
LED  
Resistors: one 330  $\Omega$ , four 1.0 k $\Omega$   
One 4-position DIP switch

### Summary of Theory

With combinational logic circuits, the outputs are determined solely by the inputs. For simple combinational circuits, truth tables are used to summarize all possible inputs and outputs; the truth table completely describes the desired operation of the circuit. The circuit may be realized by simplifying the expression for the output function as read from the truth table.

A powerful mapping technique for simplifying combinational logic circuits was developed by M. Karnaugh and was described in a paper he published

in 1953. The method involved writing the truth table into a geometric map in which adjacent cells (squares) differ from each other in only one variable. (Adjacent cells share a common border horizontally or vertically.) When you are drawing a Karnaugh map, the variables are written in a Gray code sequence along the sides and tops of the map. Each cell on the map corresponds to one row of the truth table. The output variables appear as 0's and 1's on the map in positions corresponding to those given in the truth table.

As an example, consider the design of a 2-bit comparator. The inputs will be called  $A_2A_1$  and  $B_2B_1$ . The desired output is HIGH if  $A_2A_1$  is equal to or greater than  $B_2B_1$ . To begin, the desired output is written in the form of a truth table, as given in Table 8-1. All possible inputs are clearly identified by the truth table and the desired output for every possible input is given.

Next the Karnaugh map is drawn, as shown in Figure 8-1. In this example, the map is drawn using numbers to represent the inputs. The corresponding values for the output function are entered from the truth table. The map can be read in sum-of-products (SOP) form by grouping adjacent cells containing 1's on the map. The size of the groups must be an integer power of 2 (1, 2, 4, 8, etc.) and should contain only 1's. The largest possible group should be taken; all 1's must be in at least one group and may be taken in more than one group if helpful.

After grouping the 1's on the map, the output function can be determined. Each group is read as

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