BCD to 7 Segment Display – Decoder Application

AIM

To set up and test a 7-segment static display system to display numbers 0 to 9.

LEARNING OBJECTIVE:

To learn about various applications of decoder

To learn and understand the working of IC 7448

Introduction

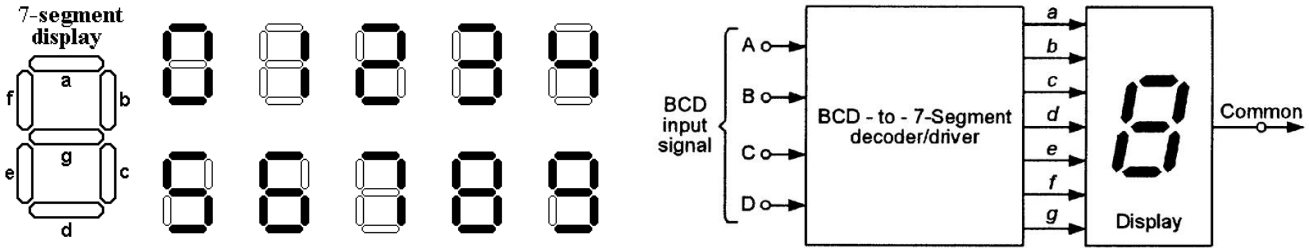
Most often seven-segment displays are used to display the digits in digital watches, calculators, clocks, measuring instruments and digital counters, etc. Generally, LCD and LED segments provide the display output of numerical numbers and characters.

A display decoder is used to convert a BCD or a binary code into a 7 segment code. It generally has 4 input lines and 7 output lines. Here we design a simple display decoder circuit using logic gates. Even though commercial BCD to 7 segment decoders are available, designing a display decoder using logic gates may prove to be beneficial from economical as well as knowledge point of view.

7 Segment Display Decoder Circuit Design

Step 1: The first step of the design involves analysis of the common cathode 7-segment display.

A 7-segment display consists of an arrangement of LEDs in an 'H' form. A truth table is constructed with the combination of inputs for each decimal number. For example, decimal number 1 would command a combination of b and c (refer the diagram given below).



Step 2: The second step involves constructing the truth table listing the 7 display input signals, decimal number and corresponding 4 digit binary numbers.

The figure below shows the truth table of a BCD to seven-segment decoder with common cathode display. In the truth table, there are 7 different output columns corresponding to each of the 7 segments.

Suppose the column for segment a shows the different combinations for which it is to be illuminated. So 'a' is active for the digits 0, 2, 3, 5, 6, 7, 8 and 9.

TRUTH TABLE:

BCD Inputs				Output Logic Levels from IC 7447 to 7-segments							Decimal number display
D	C	B	A	a	b	c	d	e	f	g	
0	0	0	0	0	0	0	0	0	0	1	0
0	0	0	1	1	0	0	1	1	1	1	1
0	0	1	0	0	0	1	0	0	1	0	2
0	0	1	1	0	0	0	0	1	1	0	3
0	1	0	0	1	0	0	1	1	0	0	4
0	1	0	1	0	1	0	0	1	0	0	5
0	1	1	0	1	1	0	0	0	0	0	6
0	1	1	1	0	0	0	1	1	1	1	7
1	0	0	0	0	0	0	0	0	0	0	8
1	0	0	1	0	0	0	1	1	0	0	9

From the above truth table, the Boolean expressions of each output functions can be written as

a = F1 (A, B, C, D) = ∑m (0, 2, 3, 5, 7, 8, 9)

b = F2 (A, B, C, D) = ∑m (0, 1, 2, 3, 4, 7, 8, 9)

c = F3 (A, B, C, D) = ∑m (0, 1, 3, 4, 5, 6, 7, 8, 9)

d = F4 (A, B, C, D) = ∑m (0, 2, 3, 5, 6, 8)

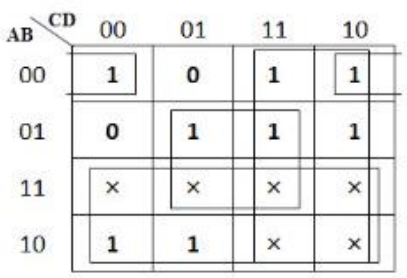
e = F5 (A, B, C, D) = ∑m (0, 2, 6, 8)

f = F6 (A, B, C, D) = ∑m (0, 4, 5, 6, 8, 9)

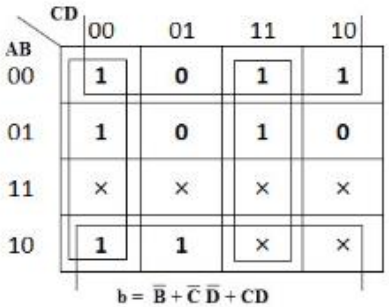
g = F7 (A, B, C, D) = ∑m (2, 3, 4, 5, 6, 8, 9)

Step 3: K-MapSimplification:

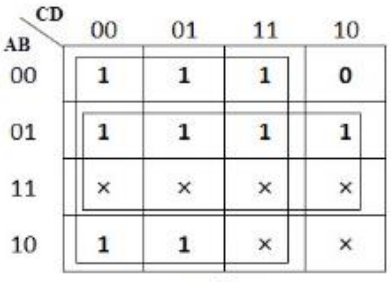
The third step involves constructing the Karnough's map for each output term and then simplifying them to obtain a logic combination of inputs for each output. The below figures shows the k-map simplification for the common cathode seven-segment decoder in order to design the combinational circuit.



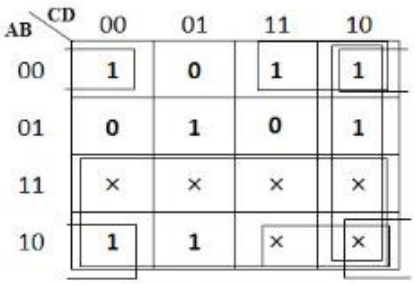
$a = A + C + BD + \overline{B}\,\overline{D}$



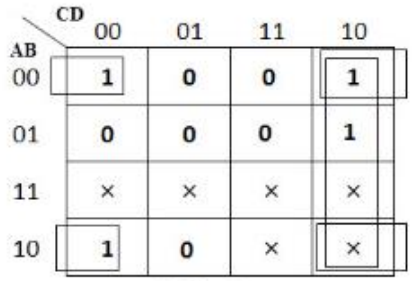
$b = \overline{B} + \overline{C}\,\overline{D} + CD$



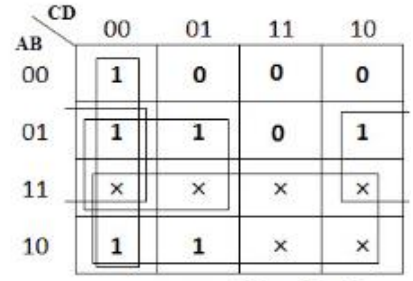
$c = B + \overline{C} + D$



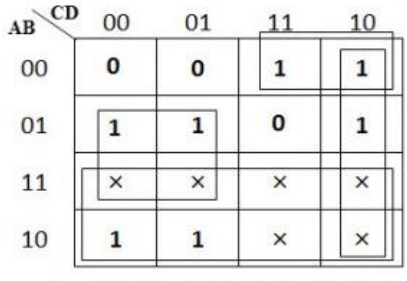
$d = \overline{B}\,\overline{D} + C\,\overline{D} + B\,\overline{C}\,D + \overline{B}\,C + A$



$e = \overline{B}\,\overline{D} + C\,\overline{D}$

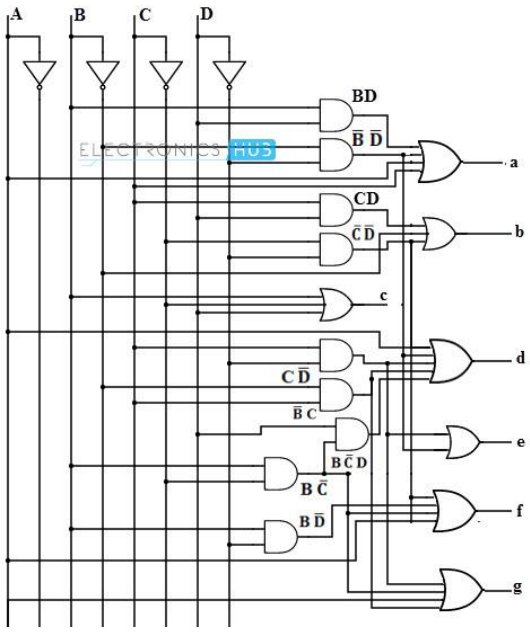


$f = A + \overline{C}\,\overline{D} + B\,\overline{C} + B\,\overline{D}$



$g = \overline{B}\,C + C\,\overline{D} + B\,\overline{C} + B\,\overline{C} + A$

Step 4: The final step involves drawing a combinational logic circuit for each output signal. Once the task was accomplished, a combinational logic circuit can be drawn using 4 inputs (A,B,C,D)and a 7- segment display (a,b,c,d,e,f,g) as output.



Applications of Seven Segment Displays

Common applications of seven segment displays are in:

- Digital clocks
- Clock radios
- Calculators
- Wristwatches
- Speedometers
- Motor-vehicle odometers
- Radio frequency indicators

Lab Tasks

Q1: Implement 7 segment display using basic logic gates, truth table and K-Map simplification.