Lecture 3B:
Seven-Segment Display

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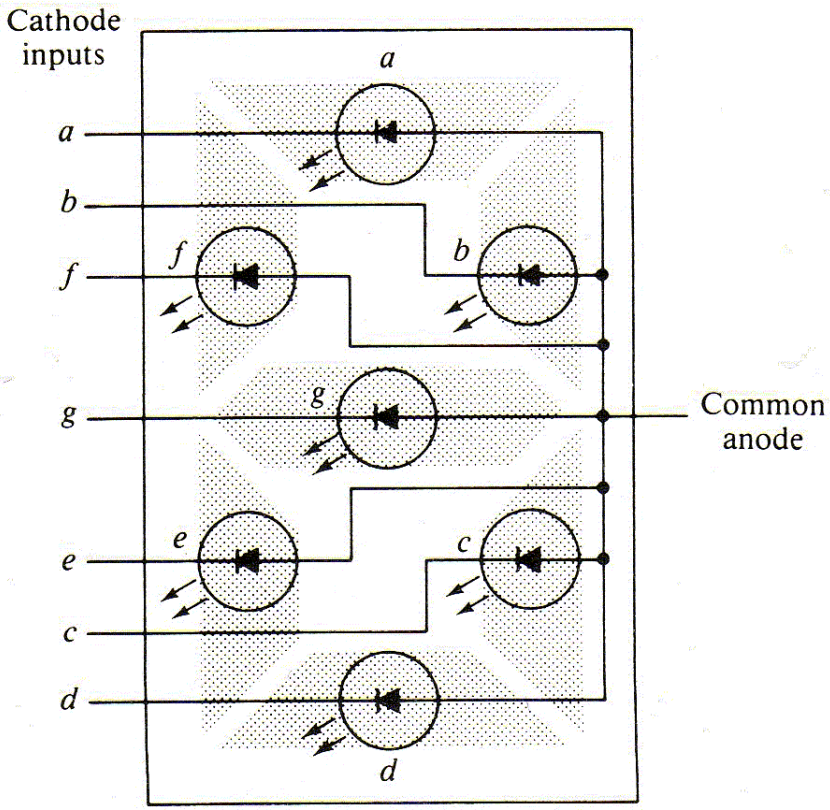
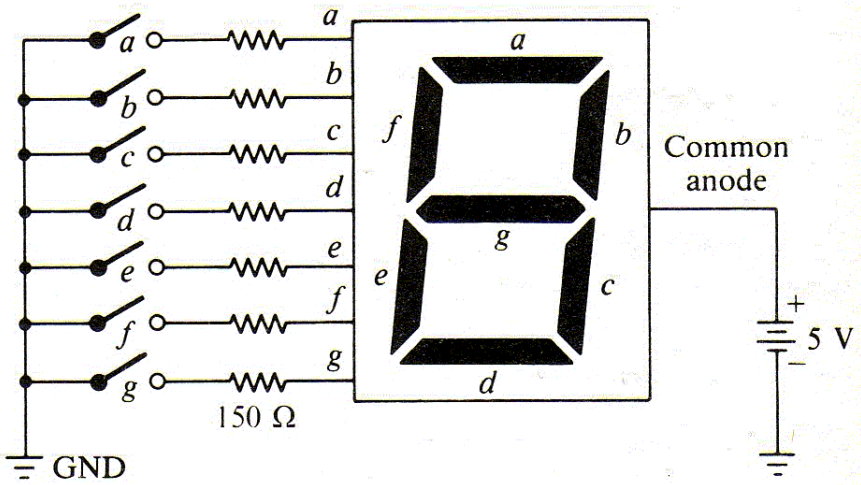
Seven Segment Display



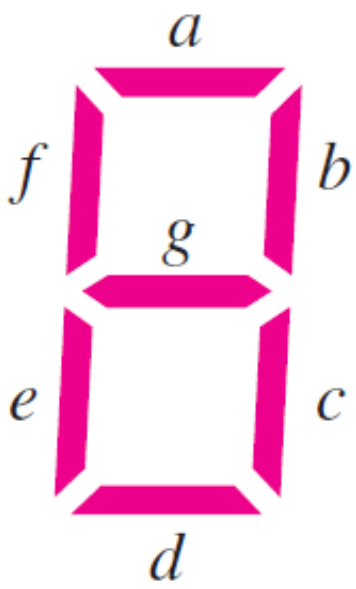
(b) Wiring of seven-segment LED display



(c) Operating seven-segment LED display

Fig. 7-11

Seven Segment Display



(a) Segment arrangement

(b) Formation of the ten digits and certain letters

Binary coded decimal (BCD) number

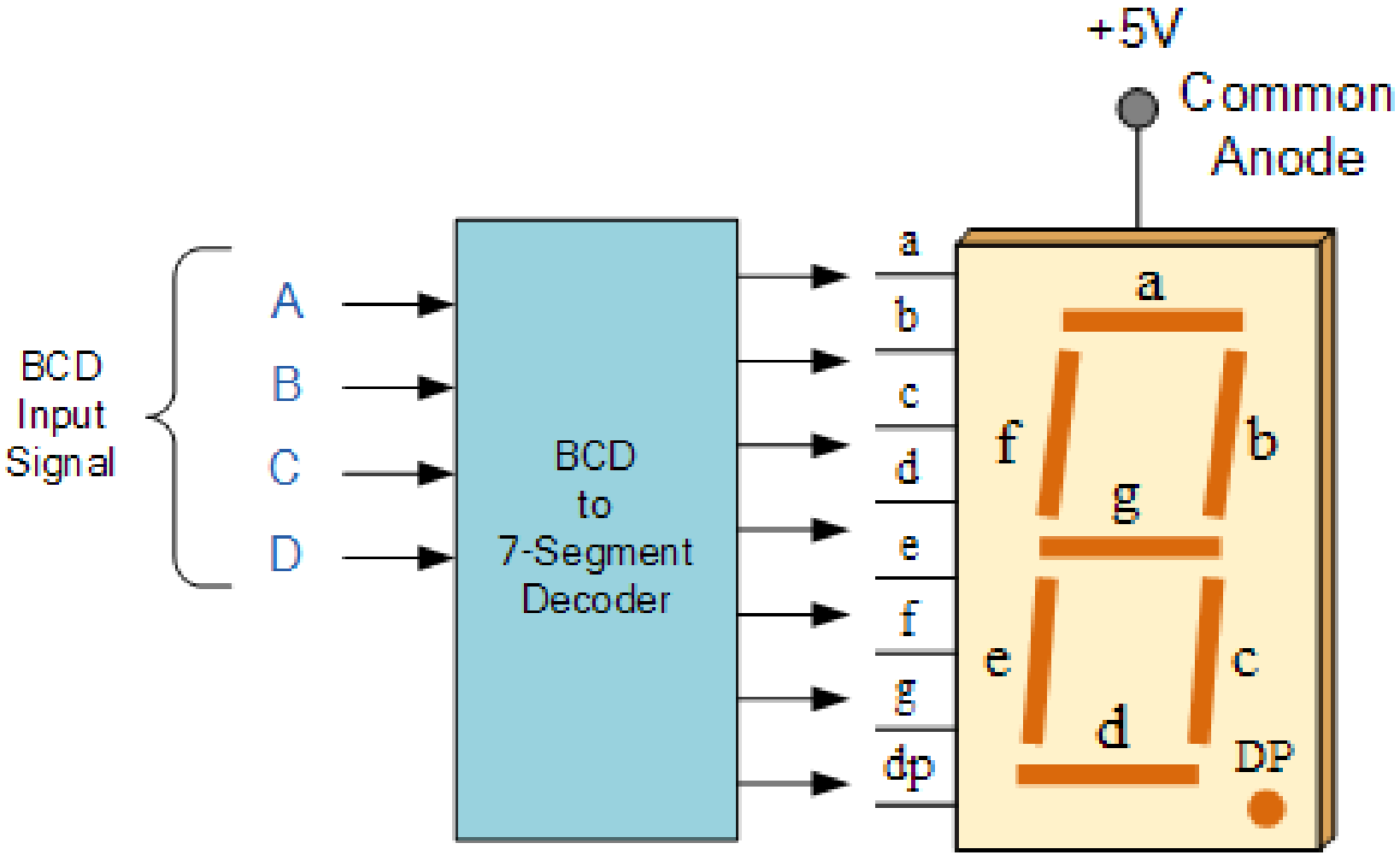
- BCD means that each decimal digit, 0 through 9, is represented by a binary code of four bits.

Decimal/BCD conversion.

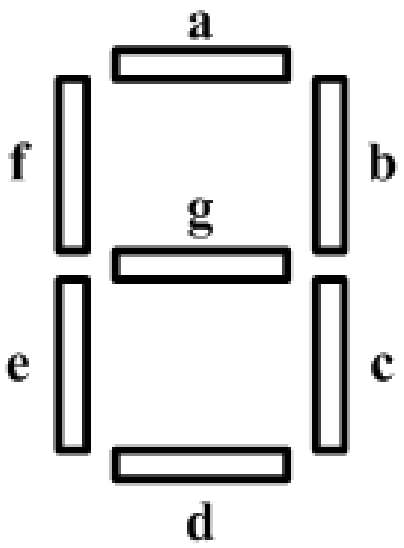
Decimal Digit	0	1	2	3	4	5	6	7	8	9
BCD	0000	0001	0010	0011	0100	0101	0110	0111	1000	1001

- Invalid Codes: 11-15
  - 1010, 1011, 1100, 1101, 1110, and 1111

7-Segment Display Circuit Diagram



Decoder Truth Table



Decimal Digit	Input BCD	Seven-Segment Decoder Outputs a b c d e f g
0	0 0 0 0	1 1 1 1 1 1 0
1	0 0 0 1	0 1 1 0 0 0 0
2	0 0 1 0	1 1 0 1 1 0 1
3	0 0 1 1	1 1 1 1 0 0 1
4	0 1 0 0	1 0 1 1 0 1 1
5	0 1 0 1	1 0 1 1 0 1 1
6	0 1 1 0	1 0 1 1 1 1 1
7	0 1 1 1	1 1 1 0 0 0 0
8	1 0 0 0	1 1 1 1 1 1 1
9	1 0 0 1	1 1 1 1 0 1 1
All other inputs		0 0 0 0 0 0 0

The Standard SOP Form

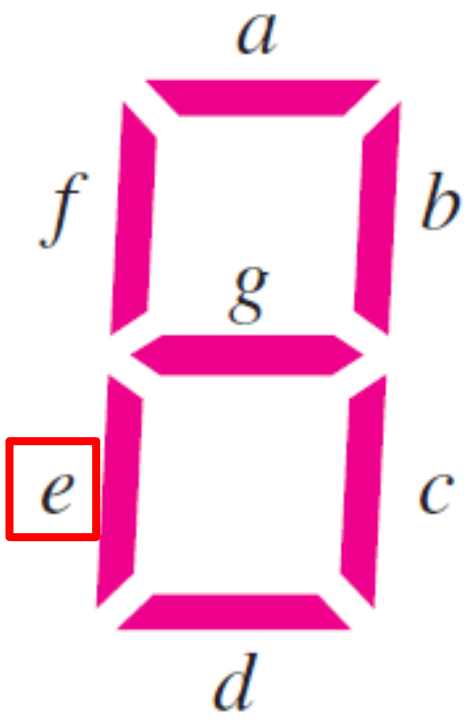
- A ***standard*** SOP expression is one in which **all the variables** in the domain appear in **each product term**
- **Binary Representation:**

$$A\overline{B}C\overline{D} = 1 \cdot \overline{0} \cdot 1 \cdot \overline{0} = 1 \cdot 1 \cdot 1 \cdot 1 = 1$$

Binary value: 1010

Constructing the Logic

Decimal Digit	Input BCD	Seven-Segment Decoder Outputs a b c d e f g
0	0 0 0 0	1 1 1 1 1 1 0
1	0 0 0 1	0 1 1 0 0 0 0
2	0 0 1 0	1 1 0 1 1 0 1
3	0 0 1 1	1 1 1 1 0 0 1
4	0 1 0 0	1 0 1 1 0 1 1
5	0 1 0 1	1 0 1 1 0 1 1
6	0 1 1 0	1 0 1 1 1 1 1
7	0 1 1 1	1 1 1 0 0 0 0
8	1 0 0 0	1 1 1 1 1 1 1
9	1 0 0 1	1 1 1 1 0 1 1
All other inputs		0 0 0 0 0 0 0



Standard SOP for e

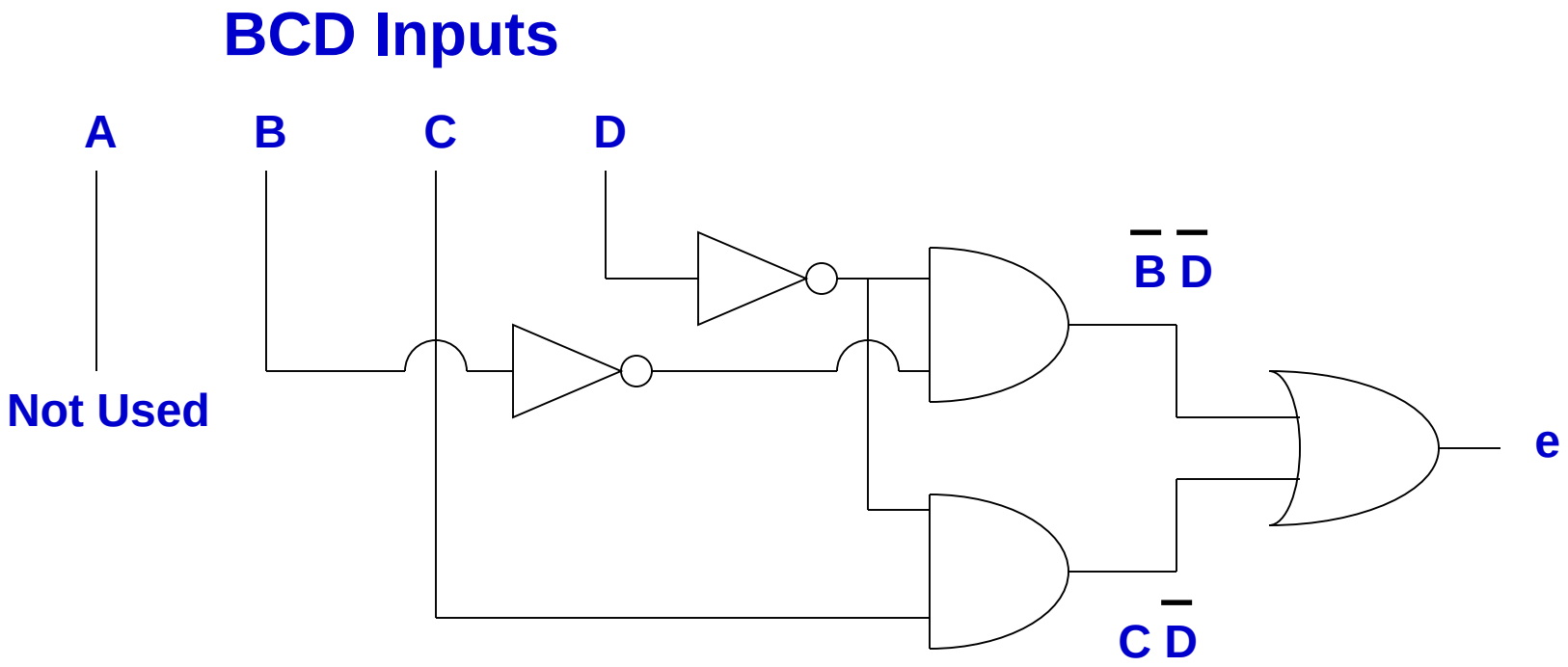
$$e = \overline{A}\,\overline{B}\,\overline{C}\,\overline{D} + \overline{A}\,\overline{B}C\,\overline{D} + \overline{A}B\,\overline{C}\,\overline{D} + A\,\overline{B}\,\overline{C}\,\overline{D}$$

0 2 6 8

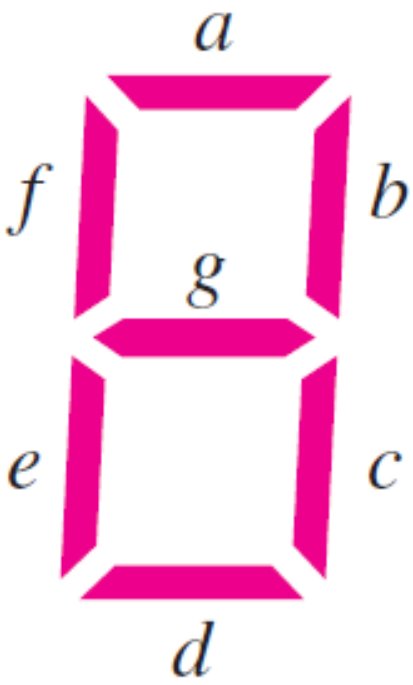
Logic Simplification

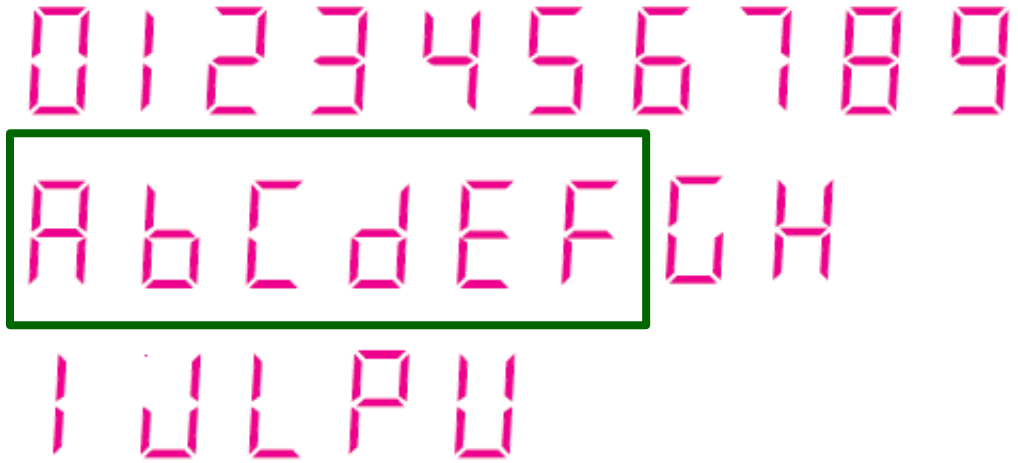
- a = A’C+A’BD+B’C’D’+AB’C’
- b = A’B’+A’C’D’+A’CD+AB’C’
- c = A’B+A’D+B’C’D’+AB’C’
- d = A’CD’+A’B’C+B’C’D’+AB’C’+A’BC’D
- e = A’CD’+B’C’D’
- f = A’BC’+A’C’D’+A’BD’+AB’C’
- g = A’CD’+A’B’C+A’BC’+AB’C’

Segment e Logic Circuit



7-Segment Display used for Letter

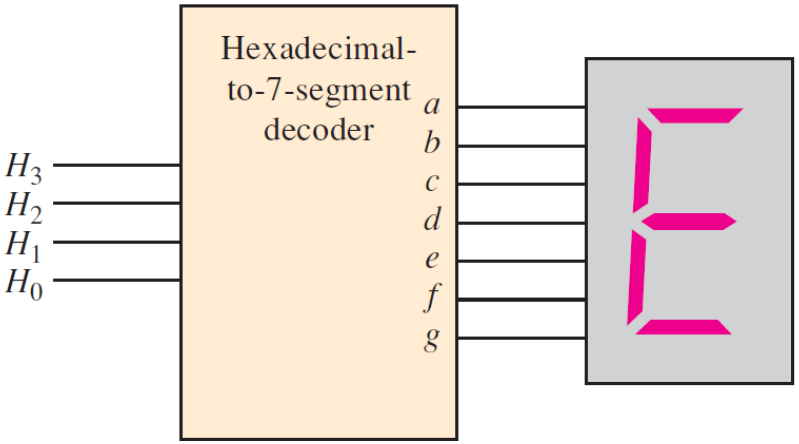




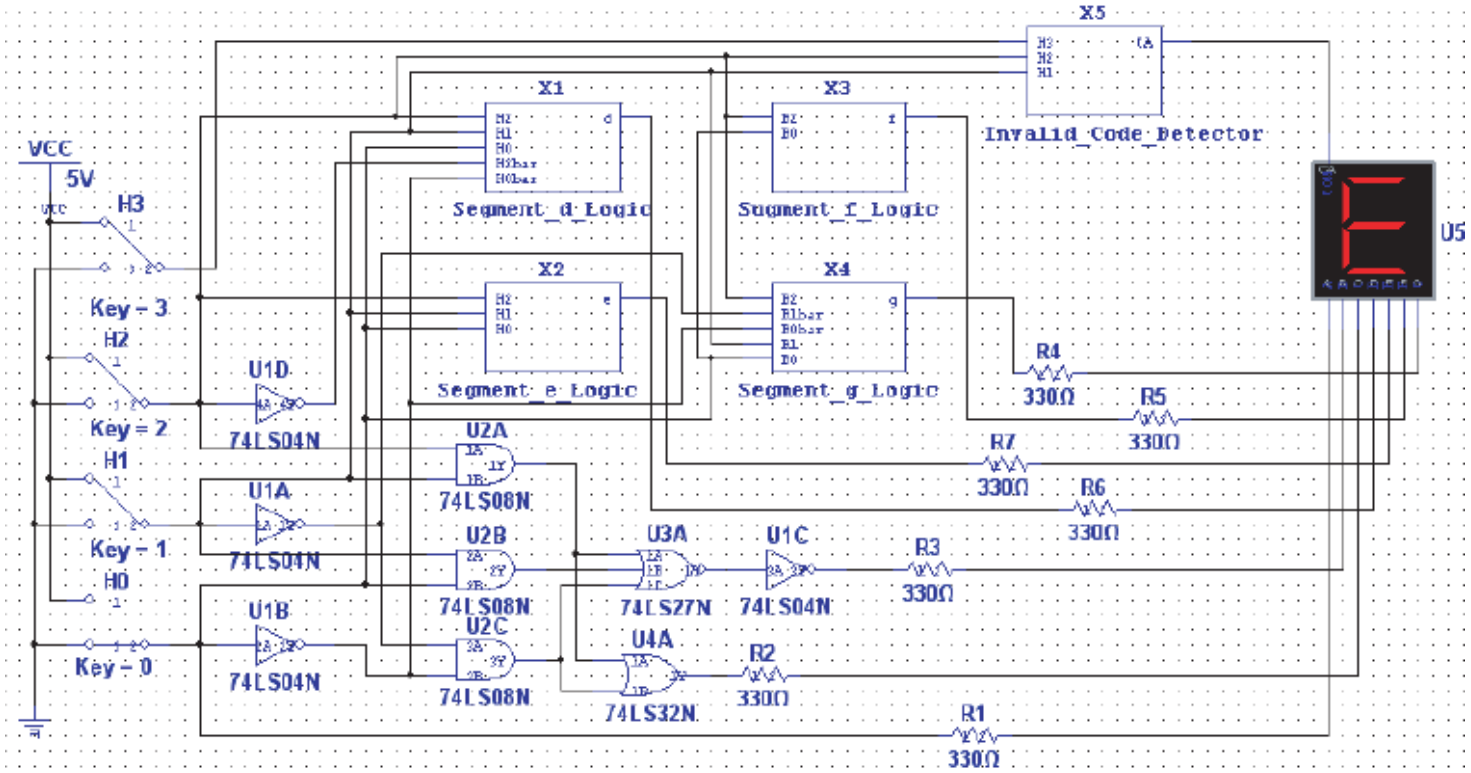
Active segments for each of the five letters used in the system display.

Letter	Segments Activated
A	*a*, *b*, *c*, *e*, *f*, *g*
b	*c*, *d*, *e*, *f*, *g*
C	*a*, *d*, *e*, *f*
d	*b*, *c*, *d*, *e*, *g*
E	*a*, *d*, *e*, *f*, *g*

7-Segment Display used for Letter



Letter	Hexadecimal Inputs H_3 H_2 H_1 H_0	Segment Ouputs a b c d e f g
A	1 0 1 0	0 0 0 1 0 0 0
b	1 0 1 1	1 1 0 0 0 0 0
C	1 1 0 0	0 1 1 0 0 0 1
d	1 1 0 1	1 0 0 0 0 1 0
E	1 1 1 0	0 1 1 0 0 0 0
F	1 1 1 1	1 1 1 1 1 1 1



Example: Digital Clock