ECE 272 Lab 3
Fall 2018

Combinational Logic (Seven-Segment Driver)

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1 Introduction

Seven-segment displays are used in various electronic devices, such as microwave, digital clock, and video cassette players. They are one of the most popular choices to display numbers and most letters on digital devices due to their easy programming and user interfaces.

A seven-segment display has seven LEDs arranged in the shape of the digit 8. Each segment has its own signal name, and all segments connect to the decoder separately. There can be an additional LEDs which has a circle shape next to the digit, representing a decimal place. Figure 1 shows what a seven-segment display looks like.

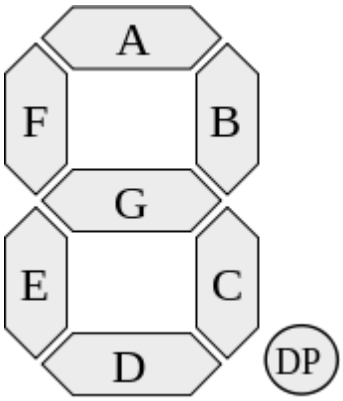

Figure 1: The LED segments and their order in a seven-segment display[1]

In this lab, I and Ben designed a seven-segment display capable of displaying hexadecimal digits. We made a decoder that convert a 4-bit binary number into a single digit on the seven-segment display. The LED layout of each of the hexadecimal digits is as follows in Figure 2:

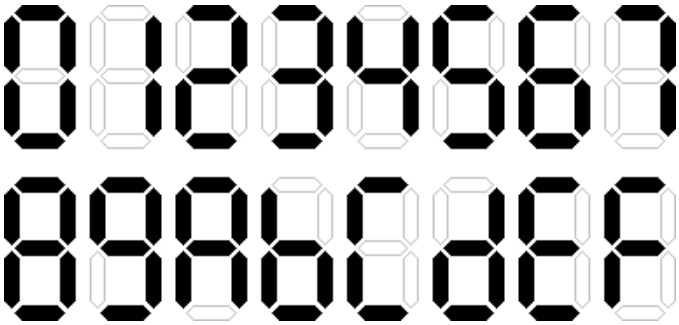

Figure 2: Seven-segment display showing hexadecimal digits [2]

2 Design

Seg_A

CD \ AB	00	01	11	10
00	0	(1)	0	0
01	(1)	0	(1)	0
11	0	0	0	(1)
10	0	0	0	0

$Seg_A = \overline{A}\overline{B}\overline{C}D + \overline{A}B\overline{C}\overline{D} + AB\overline{C}D + A\overline{B}CD$

Seg_B

CD \ AB	00	01	11	10
00	0	0	(1)	0
01	0	(1)	0	0
11	0	0	1	1
10	0	(1)	(1)	0

$Seg_B = BC\overline{D} + ACD + AB\overline{D} + \overline{A}B\overline{C}D$

Seg_C

CD \ AB	00	01	11	10
00	0	0	1	0
01	0	0	0	0
11	0	0	1	0
10	(1)	0	1	0

$Seg_C = ABC + AB\overline{D} + \overline{A}B\overline{C}D$

Seg_D

CD \ AB	00	01	11	10
00	0	(1)	0	0
01	(1)	0	0	0
11	0	(1)	(1)	0
10	0	0	0	(1)

$Seg_D = BCD + \overline{A}B\overline{C}D + \overline{A}B\overline{C}\overline{D} + A\overline{B}C\overline{D}$

Seg_E

CD \ AB	00	01	11	10
00	0	(1)	0	0
01	(1)	(1)	0	(1)
11	(1)	(1)	0	0
10	0	0	0	0

$Seg_E = \overline{A}D + \overline{A}B\overline{C} + \overline{B}C\overline{D}$

Seg_F

CD \ AB	00	01	11	10
00	0	0	0	0
01	(1)	0	(1)	0
11	(1)	(1)	0	0
10	1	0	0	0

$Seg_F = \overline{A}CD + \overline{A}B\overline{D} + \overline{A}B\overline{C} + AB\overline{C}D$

Seg_G

CD \ AB	00	01	11	10
00	(1)	0	(1)	0
01	(1)	0	0	0
11	0	(1)	0	0
10	0	0	0	0

$Seg_G = \overline{A}\overline{B}\overline{C} + \overline{A}BCD + AB\overline{C}\overline{D}$

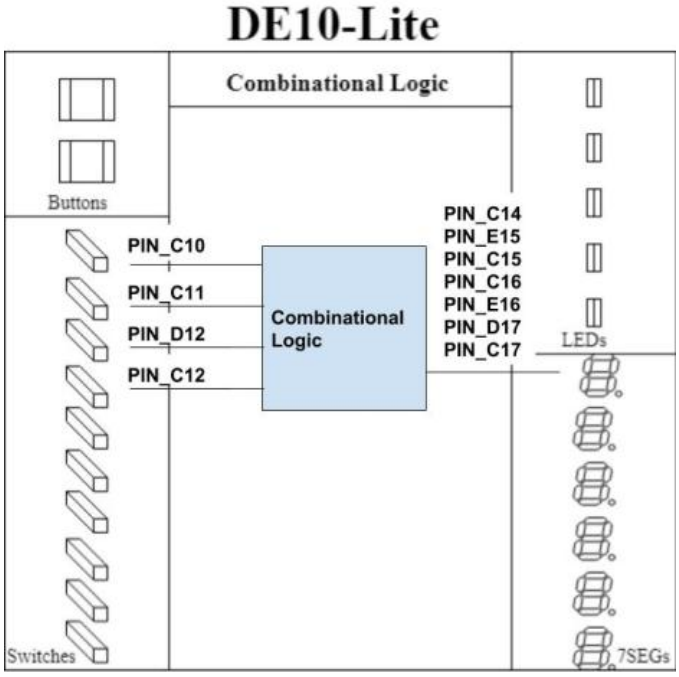

Figure 3: Block diagram

Input (Hexadecimal)	**Input (4-bit Binary)**	**$\mathbf{Seg_A}$**	**$\mathbf{Seg_B}$**	**$\mathbf{Seg_C}$**	**$\mathbf{Seg_D}$**	**$\mathbf{Seg_E}$**	**$\mathbf{Seg_F}$**	**$\mathbf{Seg_G}$**
0	0000	0	0	0	0	0	0	1
1	0001	1	0	0	1	1	1	1
2	0010	0	0	1	0	0	1	0
3	0011	0	0	0	0	1	1	0
4	0100	1	0	0	1	1	0	0
5	0101	0	1	0	0	1	0	0
6	0110	0	1	0	0	0	0	0
7	0111	0	0	0	1	1	1	1
8	1000	0	0	0	0	0	0	0
9	1001	0	0	0	0	1	0	0
a	1010	0	0	0	1	0	0	0
b	1011	1	1	0	0	0	0	0
c	1100	0	1	1	0	0	0	1
d	1101	1	0	0	0	0	1	0
e	1110	0	1	1	0	0	0	0
f	1111	0	1	1	1	0	0	0

Table 1: Conversion table between hexadecimal, 4-bit binary, and seven-segment decoder

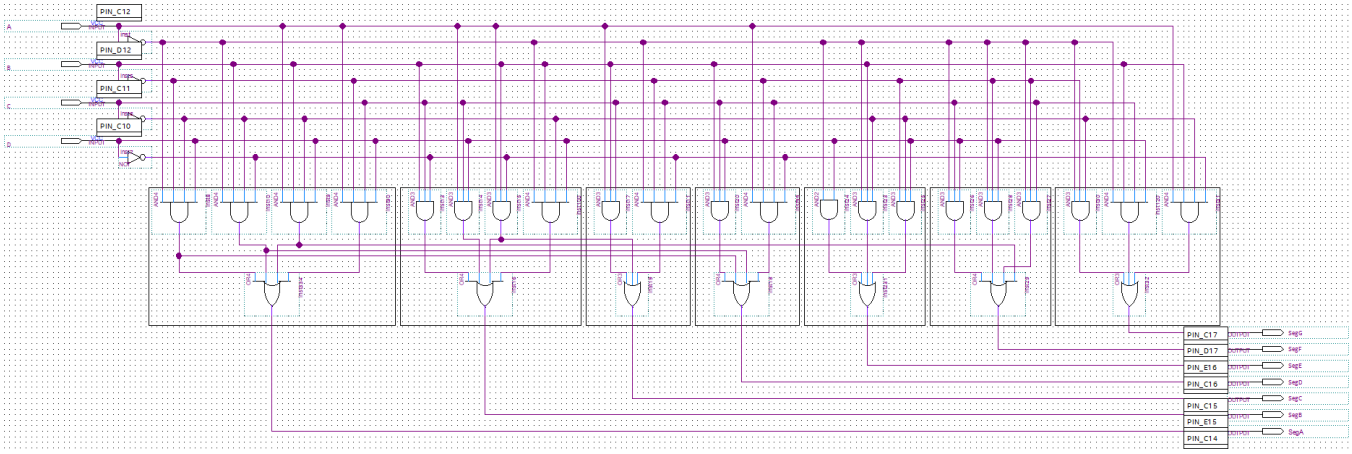

Figure 4: A schematic for the seven-segment display decoder. Due to the large difference between the size of the schematic and the available space, an image with higher resolution has been uploaded here.

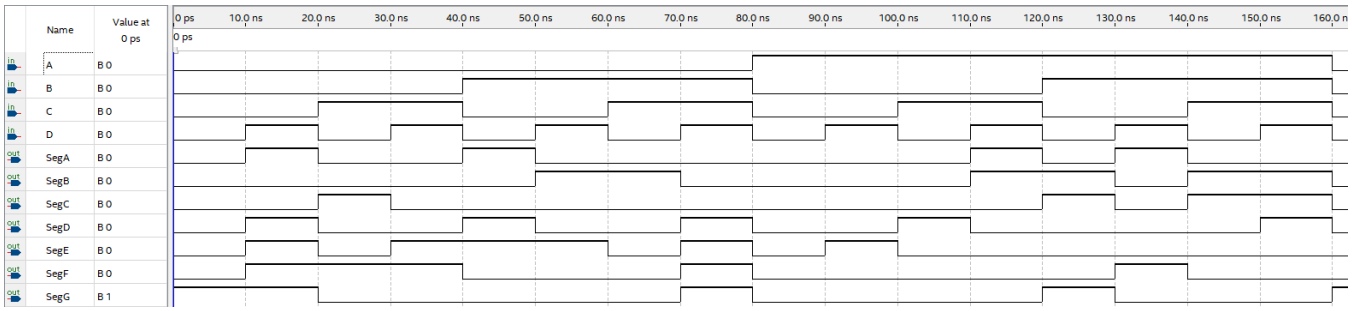

Figure 5: Simulation waveform of the program with each 10-nanosecond interval representing a hexadecimal digit

3 Results

4 Experiment Notes

Reflection

Study Questions

1. When is a simulation necessary? Was it useful for this section?

Appendix

No appendix is available in this lab.

References

[1] W. Commons, "Seven segment display." https://commons.wikimedia.org/wiki/Seven_segment_display, 2018.

[2] E. E. S. Exchange, "Hex to 7 segment decoder for a common anode 7 seg display." https://electronics.stackexchange.com/questions/373034/hex-to-7-segment-decoder-for-a-common-anode-7-seg-display, 2018.