COL215 HW Assignment 2 - 4-Digit 7-Segment Display

Submission By :

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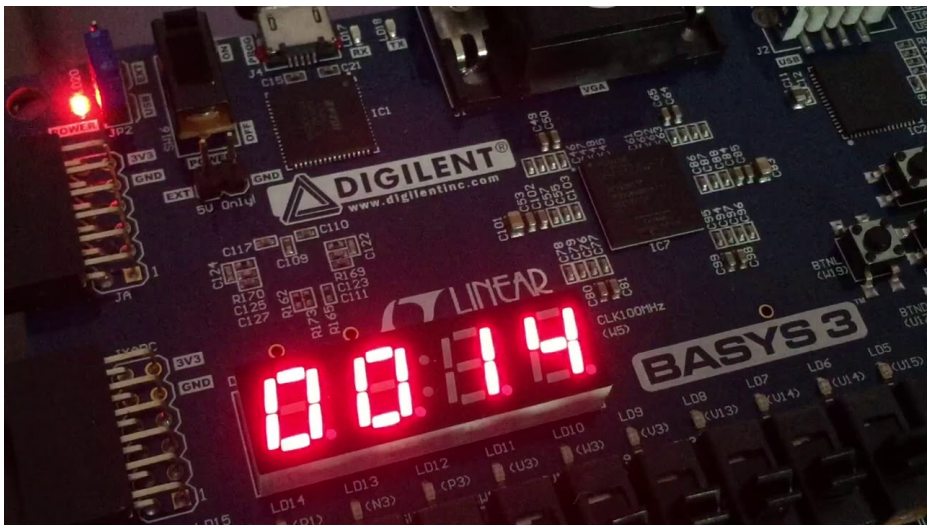


A	B	C	D	a	b	c	d	e	f	g
0	0	0	0	1	1	1	1	1	1	0
0	0	0	1	0	1	1	0	0	0	0
0	0	1	0	1	1	0	1	1	0	1
0	0	1	1	1	1	1	1	0	0	1
0	1	0	0	0	1	1	0	0	1	1
0	1	0	1	1	0	1	1	0	1	1
0	1	1	0	1	0	1	1	1	1	1
0	1	1	1	1	1	1	0	0	0	0
1	0	0	0	1	1	1	1	1	1	1
1	0	0	1	1	1	1	1	0	1	1

1 Task

Design a combinational circuit that takes a single 4-bit hexadecimal or decimal digit input from the switches and produces a 7-bit output for the seven-segment display of Basys 3 FPGA board.Extend the design to create a circuit that drives all 4 displays for displaying 4 digits together.

2 Overview

2.1 Seven-segment Decoder

2.2 Driving all four LEDs together

3 Design Decisions

3.1 Digits

Since we are implementing a hexadecimal system, we require 16 digits to represent the output. We use the following symbols.

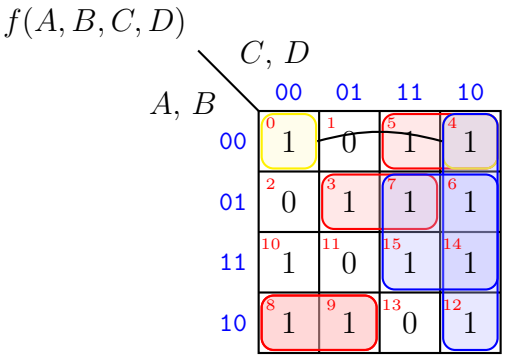
Figure 1: Caption

3.2 Truth Table

Digits & Input Bits					7 Segment Display							Min-Terms: $f(A, B, C, D)$
Digit	A	B	C	D	a	b	c	d	e	f	g	Min-Term Index
0	0	0	0	0	1	1	1	1	1	1	0	m_0
1	0	0	0	1	0	1	1	0	0	0	0	m_1
2	0	0	1	0	1	1	0	1	1	0	1	m_2
3	0	0	1	1	1	1	1	1	0	0	1	m_3
4	0	1	0	0	0	1	1	0	0	1	1	m_4
5	0	1	0	1	1	0	1	1	0	1	1	m_5
6	0	1	1	0	1	0	1	1	1	1	1	m_6
7	0	1	1	1	1	1	1	0	0	0	0	m_7
8	1	0	0	0	1	1	1	1	1	1	1	m_8
9	1	0	0	1	1	1	1	0	0	1	1	m_9
A	1	0	1	0	1	1	1	0	1	1	1	m_{10}
b	1	0	1	1	0	0	1	1	1	1	1	m_{11}
C	1	1	0	0	1	0	0	1	1	1	0	m_{12}
d	1	1	0	1	0	1	1	1	1	0	1	m_{13}
E	1	1	1	0	1	0	0	1	1	1	1	m_{14}
F	1	1	1	1	1	0	0	0	1	1	1	m_{15}

3.3 Minimizing the Combinational Logic using K-Maps

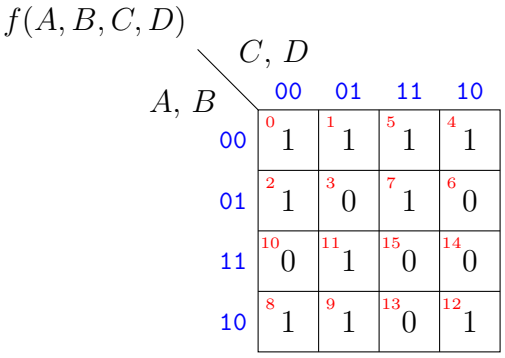
3.3.1 Segment a



The reduced formula for segment a using the mentioned K-Map reduction is as following :

$$f(A,B,C,D) = A^{'}B^{'}D^{'} + A^{'}BD + AC^{'}D^{'}$$
$$+AB^{'}C^{'} + A^{'}C + BC + CD^{'}$$

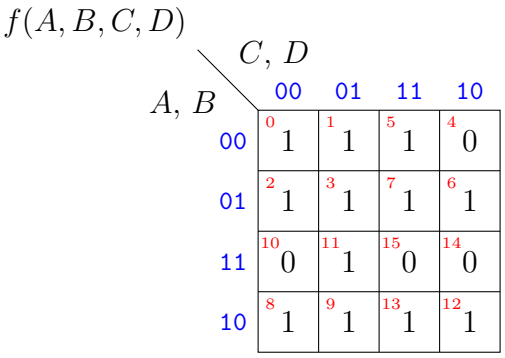
3.3.2 Segment b



The reduced formula for segment b using the mentioned K-Map reduction is as following :

$$f(A,B,C,D) = A^{'}C^{'}D^{'} + A^{'}CD +$$
$$AC^{'}D + AB^{'}C^{'} + A^{'}B^{'}$$

3.3.3 Segment c



The reduced formula for segment c using the mentioned K-Map reduction is as following :

$$f(A,B,C,D) = A^{'}CD + A^{'}C' +$$
$$A^{'}B + C^{'}D + AB^{'}$$

3.3.4 Segment d

$f(A, B, C, D)$

A, B \ C, D	00	01	11	10
00	$^{0}1$	$^{1}0$	$^{5}1$	$^{4}1$
01	$^{2}0$	$^{3}1$	$^{7}0$	$^{6}1$
11	$^{10}1$	$^{11}1$	$^{15}0$	$^{14}1$
10	$^{8}1$	$^{9}0$	$^{13}1$	$^{12}0$

The reduced formula for segment d using the mentioned K-Map reduction is as following :

$$f(A, B, C, D) = A^{'}B^{'}D^{'} + B^{'}CD+$$

$$BC^{'}D + BCD^{'} + A^{'}C^{'}D^{'}$$

3.3.5 Segment e

$f(A, B, C, D)$

A, B \ C, D	00	01	11	10
00	$^{0}1$	$^{1}0$	$^{5}0$	$^{4}1$
01	$^{2}0$	$^{3}0$	$^{7}0$	$^{6}1$
11	$^{10}1$	$^{11}1$	$^{15}1$	$^{14}1$
10	$^{8}1$	$^{9}0$	$^{13}1$	$^{12}1$

The reduced formula for segment e using the mentioned K-Map reduction is as following :

$$f(A, B, C, D) = B^{'}C^{'}D^{'} + AB+$$

$$CD^{'} + AC$$

3.3.6 Segment f

$f(A, B, C, D)$

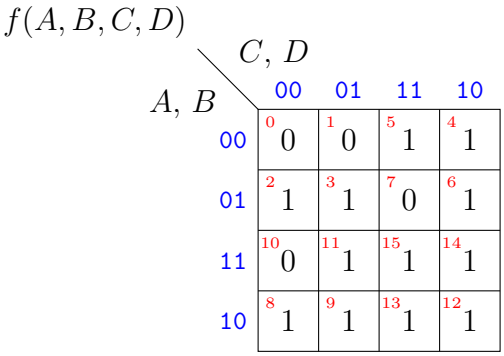
A, B \ C, D	00	01	11	10
00	$^{0}1$	$^{1}0$	$^{5}0$	$^{4}0$
01	$^{2}1$	$^{3}1$	$^{7}0$	$^{6}1$
11	$^{10}1$	$^{11}0$	$^{15}1$	$^{14}1$
10	$^{8}1$	$^{9}1$	$^{13}1$	$^{12}1$

The reduced formula for segment f using the mentioned K-Map reduction is as following :

$$f(A, B, C, D) = A^{'}BC^{'} + BCD^{'}+$$

$$AB^{'} + AC + C^{'}D^{'}$$

3.3.7 Segment g



The reduced formula for segment g using the mentioned K-Map reduction is as following :

$$f(A, B, C, D) = A^{'}B^{'}C + A^{'}BC^{'}$$

$$CD^{'} + AB^{'} + AD$$