Lab3 - Seven Segment Display

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Part A: Binary-Coded Decimal Converter:

Inputs(SW[3:0])	Display (an[0])	a	b	c	d	e	f	g
0000	**0**	0	0	0	0	0	0	1
0001	**1**	1	0	0	1	1	1	1
0010	**2**	0	0	1	0	0	1	0
0011	**3**	0	0	0	0	1	1	0
0100	**4**	1	0	0	1	1	0	0
0101	**5**	0	1	0	0	1	0	0
0110	**6**	0	1	0	0	0	0	0
0111	**7**	0	0	0	1	1	1	1
1000	**8**	0	0	0	0	0	0	0
1001	**9**	0	0	0	0	1	0	0
1010	**A**	0	0	0	1	0	0	0
1011	**b**	1	1	0	0	0	0	0
1100	**C**	0	1	1	0	0	0	1
1101	**d**	1	0	0	0	0	1	0
1110	**E**	0	1	1	0	0	0	0
1111	**F**	0	1	1	1	0	0	0

K-Mapping:

a	00	01	11	10
00	0	1	0	0
01	1	0	0	0
11	0	1	0	0
10	0	0	1	0

b	00	01	11	10
00	0	0	0	0
01	0	1	0	1
11	1	0	1	1
10	0	0	1	0

c	00	01	11	10
00	0	0	0	1
01	0	0	0	0
11	1	0	1	1
10	0	0	0	0

d	00	01	11	10
00	0	1	0	0
01	1	0	1	0
11	0	0	1	0
10	0	0	0	1

e	00	01	11	10
00	0	1	1	0
01	1	1	1	0
11	0	0	0	0
10	0	1	0	0

f	00	01	11	10
00	0	1	1	1
01	0	0	1	0
11	0	1	0	0
10	0	0	0	0

g	00	01	11	10
00	1	1	0	0
01	0	0	1	0
11	1	0	0	0
10	0	0	0	0

a	00	01	11	10
00	0	1	0	0
01	1	0	0	0
11	0	1	0	0
10	0	0	1	0

SW3'∧SW2'∧SW1'∧SW0

SW3'∧SW2∧SW1'∧SW0'

SW3∧SW2∧SW1'∧SW0

SW3∧SW2'∧SW1'∧SW0

b	00	01	11	10
00	0	0	0	0
01	0	1	0	1
11	1	0	1	1
10	0	0	1	0

SW3'∧SW2∧SW1'∧SW0

SW2∧SW1∧SW0'

SW3∧SW2∧SW1'∧SW0'

SW3∧SW1∧SW0

c	00	01	11	10
00	0	0	0	1
01	0	0	0	0
11	1	0	1	1
10	0	0	0	0

SW3'∧SW2'∧SW1∧SW0'

SW3∧SW2∧SW1

SW3∧SW2∧SW0'

d	00	01	11	10
00	0	1	0	0
01	1	0	1	0
11	0	0	1	0
10	0	0	0	1

SW3'∧SW2'∧SW1'∧SW0

SW3'∧SW2∧SW1'∧SW0'

SW2∧SW1∧SW0

SW3∧SW2'∧SW1∧SW0'

e	00	01	11	10
00	0	1	1	0
01	1	1	1	0
11	0	0	0	0
10	0	1	0	0

SW3'∧SW0

SW3'∧SW2∧SW1'

SW0∧SW1'∧SW2'

f	00	01	11	10
00	0	1	1	1
01	0	0	1	0
11	0	1	0	0
10	0	0	0	0

SW3'∧SW2'∧SW0

SW3'∧SW2'∧SW1

SW3'∧SW1∧SW0

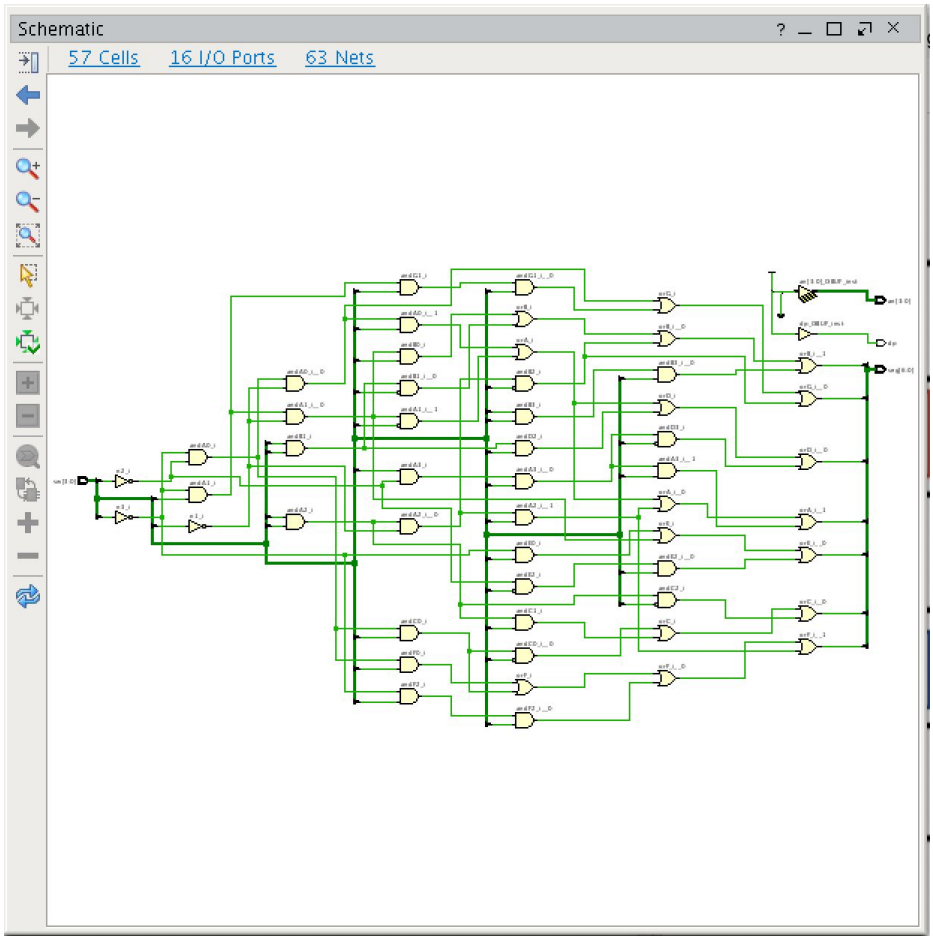
SW3∧SW2∧SW1'∧SW0

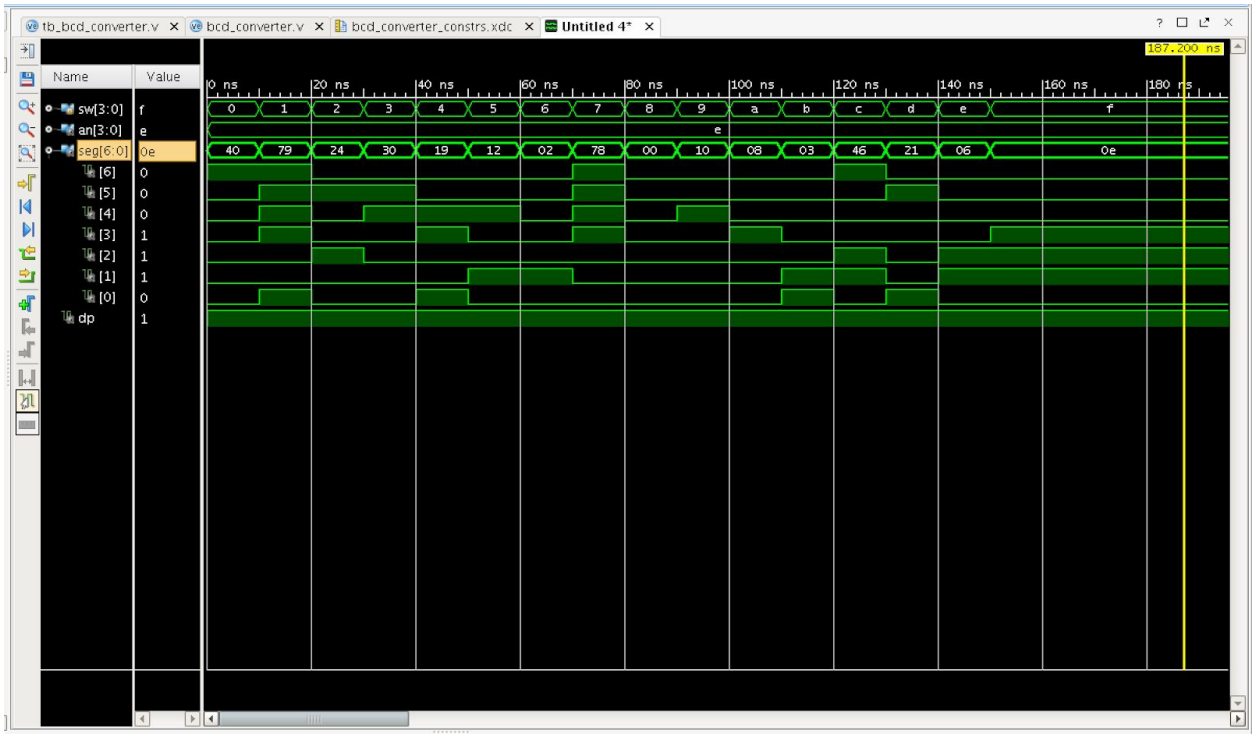
g	00	01	11	10
00	1	1	0	0
01	0	0	1	0
11	1	0	0	0
10	0	0	0	0

SW3'∧SW2'∧SW1'

SW3'∧SW2∧SW1∧SW0

SW3∧SW2∧SW1'∧SW0'


Schematic
57 Cells
16 I/O Ports
63 Nets


tb_bcd_converter.v
bcd_converter.v
bcd_converter_constrs.xdc
Untitled 4*
187.200 ns
Name
Value
sw[3:0]
an[3:0]
seg[6:0]
[6]
[5]
[4]
[3]
[2]
[1]
[0]
dp
0 ns
20 ns
40 ns
60 ns
80 ns
100 ns
120 ns
140 ns
160 ns
180 ns
0 1 2 3 4 5 6 7 8 9 a b c d e f
e
40 79 24 30 19 12 02 78 00 10 08 03 46 21 06 0e

Sum-of-Products Forms:

A = (~sw[3] & ~sw[2] & ~sw[1] & sw[0]) |
(~sw[3] & sw[2] & ~sw[1] & ~sw[0]) |
(sw[3] & sw[2] & ~sw[1] & sw[0]) |
(sw[3] & ~sw[2] & sw[1] & sw[0])

B = (~sw[3] & sw[2] & ~sw[1] & sw[0]) |
(sw[2] & sw[1] & ~sw[0]) |
(sw[3] & sw[2] & ~sw[1] & ~sw[0]) |
(sw[3] & sw[1] & sw[0])

C = (~sw[3] & ~sw[2] & sw[1] & ~sw[0]) |
(sw[3] & sw[2] & sw[1]) |
(sw[3] & sw[2] & ~sw[0])

D = (~sw[3] & ~sw[2] & ~sw[1] & sw[0]) |
(~sw[3] & sw[2] & ~sw[1] & ~sw[0]) |
(sw[2] & sw[1] & sw[0]) |
(sw[3] & ~sw[2] & sw[1] & ~sw[0])

E = (~sw[3] & sw[0]) |
(~sw[3] & sw[2] & ~sw[1]) |
(sw[0] & ~sw[1] & ~sw[2])

F = (~sw[3] & ~sw[2] & sw[0]) |
(~sw[3] & ~sw[2] & sw[1]) |
(~sw[3] & sw[1] & sw[0]) |
(sw[3] & sw[2] & ~sw[1] & sw[0])

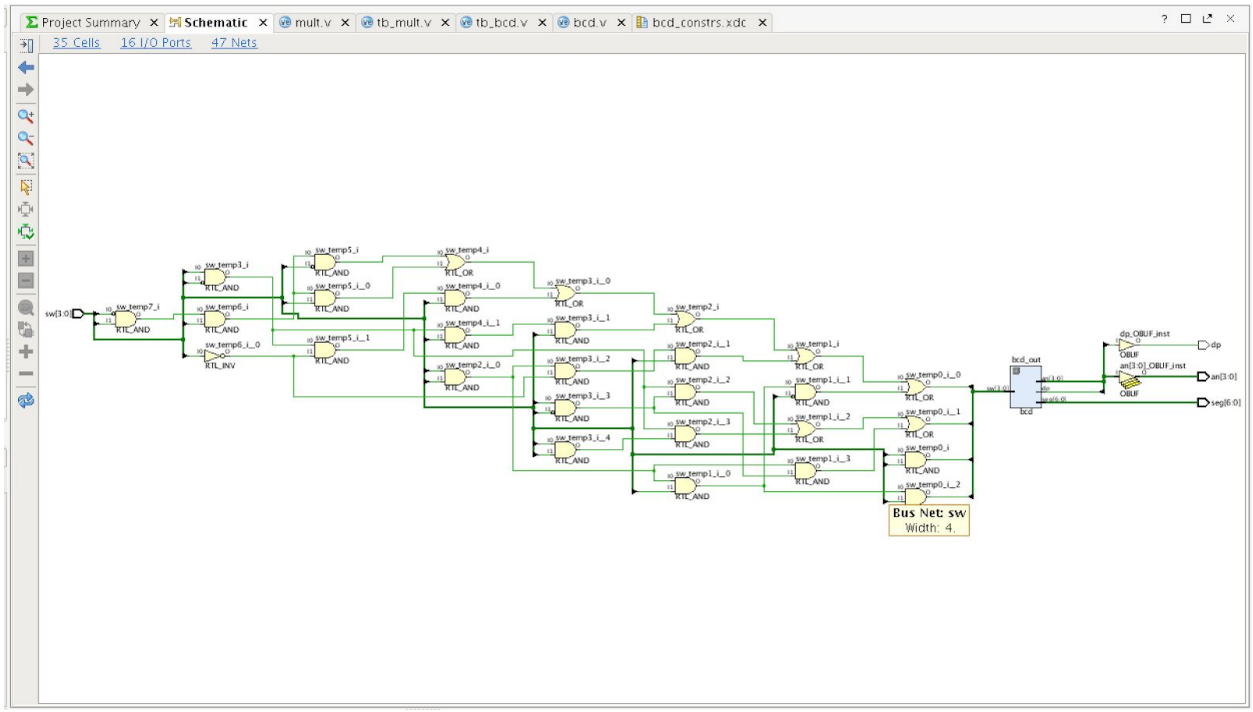
G = (~sw[3] & ~sw[2] & ~sw[1]) |
(~sw[3] & sw[2] & sw[1] & sw[0]) |
(sw[3] & sw[2] & ~sw[1] & ~sw[0])

Part B: Multiplier

SW [3:2]	SW [1:0]	Product (decimal)	Product (4-bit binary)
00	00	0	0000
00	01	0	0000
00	10	0	0000
00	11	0	0000
01	00	0	0000
01	01	1	0001
01	10	2	0010
01	11	3	0011
10	00	0	0000
10	01	2	0010
10	10	4	0100
10	11	6	0110
11	00	0	0000
11	01	3	0011
11	10	6	0110
11	11	9	1001

Sum-of-Products Forms:

```
product[0] =   (sw[2] & sw[0])
product[1] =   (~sw[3]&sw[2]&sw[1]&~sw[0]) |
               (~sw[3]&sw[2]&sw[1]&sw[0]) |
               (sw[3]&~sw[2]&~sw[1]&sw[0]) |
               (sw[3]&~sw[2]&sw[1]&sw[0]) |
               (sw[3]&sw[2]&~sw[1]&sw[0]) |
               (sw[3]&sw[2]&sw[1]&~sw[0]);
product[2] =   (sw[3] & ~sw[2]) & (sw[1] & ~sw[0]) |
               (sw[3] & ~sw[2]) & (sw[1] & sw[0]) |
               (sw[3] & sw[2]) & (sw[1] & ~sw[0])
product[3] =   (sw[3] & sw[2]) & (sw[1] & sw[0])
```


Project Summary
Schematic
mult.v
tb_mult.v
tb_bcd.v
bcd.v
bcd_constrs.xdc
35 Cells
16 I/O Ports
47 Nets
Bus Net: sw
Width: 4.


mult.v
tb_mult.v
tb_bcd.v
bcd.v
bcd_constrs.xdc
Untitled 13
Name
Value
sw[3:0]
an[3:0]
seg[6:0]
[6]
[5]
[4]
[3]
[2]
[1]
[0]
dp
23.530 ns
40 ns
60 ns
80 ns
100 ns
120 ns
140 ns
160 ns
180 n