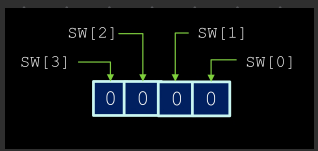
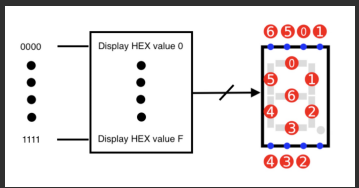
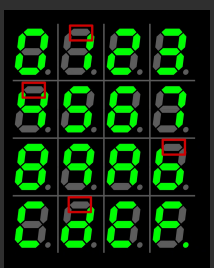
1. In your lab report, derive seven truth tables, one for each segment of the 7-segment decoder. Another way to ask this question is: which segments should be on (and which should be off) for a given character?





Segment 0

- ON at all times But
  - → 1, 4, 6, d
  - → 0001, 0100, 1011, 1101



$D_{3:0}$	Character
0000	0
0001	1
0010	2
0011	3
0100	4
0101	5
0110	6
0111	7
1000	8
1001	9
1010	A
1011	b
1100	c
1101	d
1110	E
1111	F

All combinations of Sw1, Sw0

All combinations of Sw3, Sw2

	$\overline{SW1}*\overline{SW0}$ (0 0)	$\overline{SW1}*SW0$ (0 1)	$SW1*SW0$ (1 1)	$SW1*\overline{SW0}$ (1 0)
$\overline{SW3}*\overline{SW2}$ (0 0)	1	0	1	1
$\overline{SW3}*SW2$ (0 1)	0	1	1	1
$SW3*SW2$ (1 1)	1	0	1	1
$SW3*\overline{SW2}$ (1 0)	1	1	0	1

$\overline{SW2}\cdot\overline{SW0}$ +
$\overline{SW3}\cdot SW1$ +
$SW2\cdot SW1$ +
$SW3\cdot\overline{SW0}$ +
$\overline{SW3}\cdot SW2\cdot SW0$
$SW3\cdot\overline{SW2}\cdot\overline{SW1}$

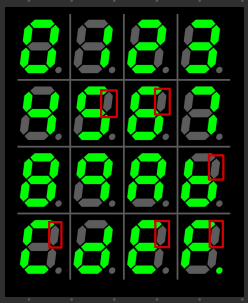
A 3
B 2
C 1
D 0

will be 0 when

Sw3	Sw2	Sw1	Sw0
0	0	0	1
0	1	0	0
1	0	1	1
1	1	0	1

Segment 1

- ON at all times but
  → 0101, 0110, 1011, 1100, 1110, 1111
  5, 6, b, c, E, F



$D_{3:0}$	Character
0000	0
0001	1
0010	2
0011	3
0100	4
0101	5
0110	6
0111	7
1000	8
1001	9
1010	8
1011	b
1100	c
1101	d
1110	E
1111	F

	$\overline{SW1}*\overline{SW0}$	$\overline{SW1}*SW0$	$SW1*SW0$	$SW1*\overline{SW0}$
$\overline{SW3}*\overline{SW2}$	1	1	1	1
$\overline{SW3}*SW2$	1	0	1	0
$SW3*SW2$	0	1	0	0
$SW3*\overline{SW2}$	1	1	0	1

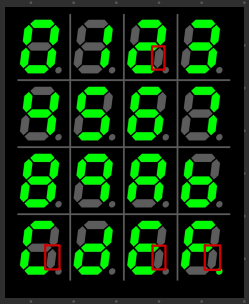
$\overline{SW3}\cdot\overline{SW2}$ +
$\overline{SW0}\cdot\overline{SW2}$ +
$\overline{SW0}\cdot\overline{SW1}\cdot\overline{SW3}$ +
$\overline{SW3}\cdot SW1\cdot SW0$ +
$SW3\cdot\overline{SW1}\cdot SW0$

A 3
B 2
C 1
D 0

Will be 0 when:

SW3	SW2	SW1	SW0
0	1	0	1
0	1	1	0
1	0	1	1
1	1	0	0
1	1	1	0
1	1	1	1

Segment 2



$D_{3:0}$	Character
0000	0
0001	1
0010	2
0011	3
0100	4
0101	5
0110	6
0111	7
1000	8
1001	9
1010	A
1011	b
1100	c
1101	d
1110	E
1111	F

	$\overline{SW1}*\overline{SW0}$ (0 0)	$\overline{SW1}*SW0$ (0 1)	$SW1*SW0$ (1 1)	$SW1*\overline{SW0}$ (1 0)
$\overline{SW3}*\overline{SW2}$ (0 0)	1	1	1	0
$\overline{SW3}*SW2$ (0 1)	1	1	1	1
$SW3*SW2$ (1 1)	0	1	0	0
$SW3*\overline{SW2}$ (1 0)	1	1	1	1

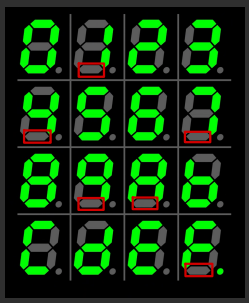
$\overline{SW3}\cdot\overline{SW1}$ +
$\overline{SW3}\cdot\overline{SW0}$ +
$\overline{SW1}\cdot\overline{SW0}$ +
$\overline{SW3}\cdot SW2$ +
$SW3\cdot\overline{SW2}$

A 3
B 2
C 1
D 0

Will be 0 when:

SW3	SW2	SW1	SW0
0	0	1	0
1	1	0	0
1	1	1	0
1	1	1	1

Segment 3



$D_{3:0}$	Character
0000	0
0001	1
0010	2
0011	3
0100	4
0101	5
0110	6
0111	7
1000	8
1001	9
1010	A
1011	b
1100	c
1101	d
1110	E
1111	F

	$\overline{SW1}*\overline{SW0}$	$\overline{SW1}*SW0$	$SW1*SW0$	$SW1*\overline{SW0}$
$\overline{SW3}*\overline{SW2}$	1	0	1	1
$\overline{SW3}*SW2$	0	1	0	1
$SW3*SW2$	1	1	0	1
$SW3*\overline{SW2}$	1	0	1	0

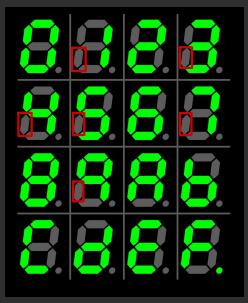
$\overline{SW3}\cdot\overline{SW2}\cdot\overline{SW0} +$
$\overline{SW2}\cdot SW1\cdot SW0 +$
$SW2\cdot\overline{SW1}\cdot SW0 +$
$SW2\cdot SW1\cdot\overline{SW0} +$
$SW3\cdot\overline{SW1}\cdot\overline{SW0}$

A 3
B 2
C 1
D 0

Will be 0 when:

SW3	SW2	SW1	SW0
0	0	0	1
0	1	0	0
0	1	1	1
1	0	0	1
1	0	1	0
1	1	1	1

Segment 4



$D_{3:0}$	Character
0000	0
0001	1
0010	2
0011	3
0100	4
0101	5
0110	6
0111	7
1000	8
1001	9
1010	A
1011	b
1100	c
1101	d
1110	E
1111	F

	$\overline{SW1}*\overline{SW0}$	$\overline{SW1}*SW0$	$SW1*SW0$	$SW1*\overline{SW0}$
$\overline{SW3}*\overline{SW2}$	1	0	0	1
$\overline{SW3}*SW2$	0	0	0	1
$SW3*SW2$	1	1	1	1
$SW3*\overline{SW2}$	1	0	1	1

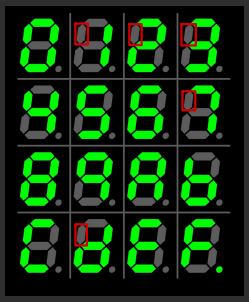
$\overline{SW2}\cdot\overline{SW0} +$
$SW1\cdot\overline{SW0} +$
$SW3\cdot SW1 +$
$SW3\cdot SW2$

A 3
B 2
C 1
D 0

Will be 0 when:

SW3	SW2	SW1	SW0
0	0	0	1
0	0	1	1
0	1	0	0
0	1	0	1
0	1	1	1
1	0	0	1

Segment 5



$D_{3:0}$	Character
0000	0
0001	1
0010	2
0011	3
0100	4
0101	5
0110	6
0111	7
1000	8
1001	9
1010	A
1011	b
1100	c
1101	d
1110	E
1111	F

	$\overline{SW1}*\overline{SW0}$	$\overline{SW1}*SW0$	$SW1*SW0$	$SW1*\overline{SW0}$
$\overline{SW3}*\overline{SW2}$	1	0	0	0
$\overline{SW3}*SW2$	1	1	0	1
$SW3*SW2$	1	0	1	1
$SW3*\overline{SW2}$	1	1	1	1

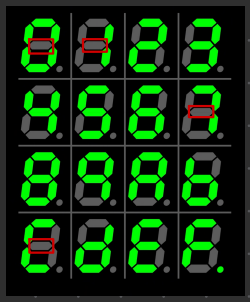
$\overline{SW1}\cdot\overline{SW0} +$
$SW2\cdot\overline{SW0} +$
$SW3\cdot\overline{SW2} +$
$SW3\cdot SW1 +$
$\overline{SW3}\cdot SW2\cdot\overline{SW1}$

A 3
B 2
C 1
D 0

Will be 0 when:

SW3	SW2	SW1	SW0
0	0	0	1
0	0	1	0
0	0	1	1
1	1	0	1

Segment 6



$D_{3:0}$	Character
0000	0
0001	1
0010	2
0011	3
0100	4
0101	5
0110	6
0111	7
1000	8
1001	9
1010	A
1011	b
1100	c
1101	d
1110	E
1111	F

	$\overline{SW1}*\overline{SW0}$	$\overline{SW1}*SW0$	$SW1*SW0$	$SW1*\overline{SW0}$
$\overline{SW3}*\overline{SW2}$	0	0	1	1
$\overline{SW3}*SW2$	1	1	0	1
$SW3*SW2$	0	1	1	1
$SW3*\overline{SW2}$	1	1	1	1

$\overline{SW2}\cdot SW1 +$

$SW1\cdot \overline{SW0} +$

$SW3\cdot \overline{SW2} +$

$SW3\cdot SW0 +$

$\overline{SW3}\cdot SW2\cdot \overline{SW1}$

A 3

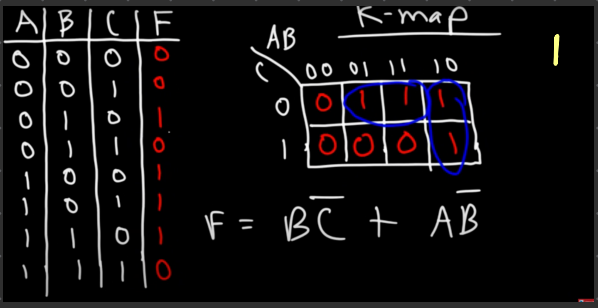
B 2

C 1

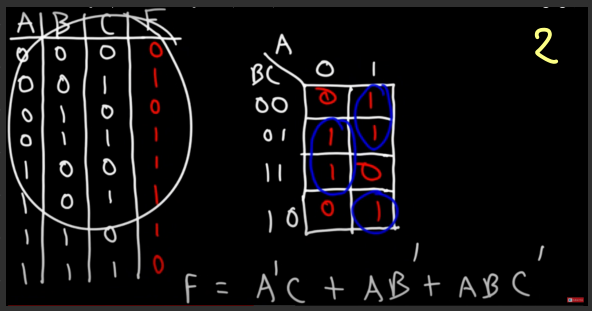
D 0

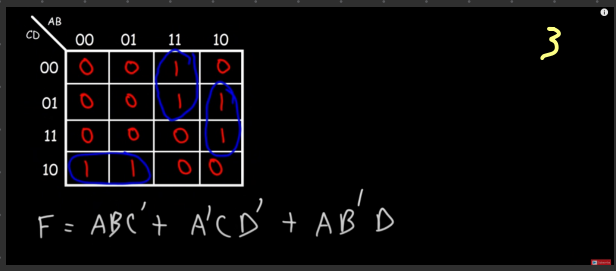
Will be 0 when:

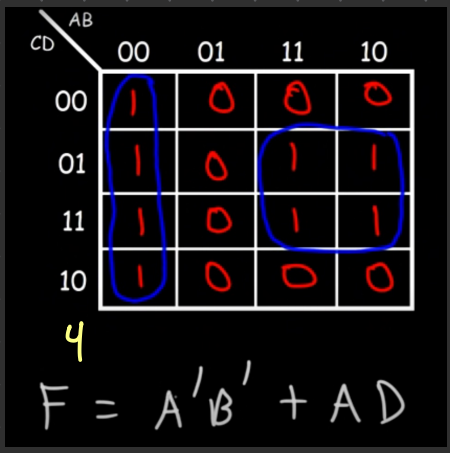
SW3	SW2	SW1	SW0
0	0	0	1
0	0	1	0
0	0	1	1
1	1	0	1



- Easier example of k-map grouping
→ In 1, 2, 3 its easy to see the pattern, look at non-changing elements, ignore the rest







- We can apply the same logic for more than 2 boxes
- Note that We can group diagonals

$D_{3:0}$	Character
0000	0
0001	1
0010	2
0011	3
0100	4
0101	5
0110	6
0111	7
1000	8
1001	9
1010	A
1011	b
1100	c
1101	d
1110	E
1111	F

A 3
B 2
C 1
D 0

$$S_0 = (\overline{B} \cdot \overline{D}) + (\overline{A} \cdot C) + (B \cdot C) + (A \cdot \overline{D}) + (\overline{A} \cdot B \cdot D) + (A \cdot \overline{B} \cdot \overline{C})$$
$$S_1 = (\overline{A} \cdot \overline{B}) + (\overline{D} \cdot \overline{B}) + (\overline{D} \cdot \overline{C} \cdot \overline{A}) + (\overline{A} \cdot C \cdot D) + (A \cdot \overline{C} \cdot \overline{D})$$
$$S_2 = (\overline{A} \cdot \overline{C}) + (\overline{A} \cdot D) + (\overline{C} \cdot D) + (\overline{A} \cdot B) + (A \cdot \overline{B})$$
$$S_3 = (\overline{A} \cdot \overline{B} \cdot \overline{D}) + (\overline{B} \cdot C \cdot D) + (B \cdot \overline{C} \cdot D) + (B \cdot C \cdot \overline{D}) + (A \cdot \overline{C} \cdot \overline{D})$$
$$S_4 = (\overline{B} \cdot \overline{D}) + (C \cdot \overline{D}) + (A \cdot C) + (A \cdot B)$$
$$S_5 = (\overline{C} \cdot \overline{D}) + (B \cdot \overline{D}) + (A \cdot \overline{B}) + (A \cdot C) + (\overline{A} \cdot B \cdot \overline{C})$$
$$S_6 = (\overline{B} \cdot C) + (C \cdot \overline{D}) + (A \cdot \overline{B}) + (A \cdot D) + (\overline{A} \cdot B \cdot \overline{C})$$