

4 bit input

1 bit output: (1,0)

Inputs: X_3, X_2, X_1, X_0

Outputs: a, b, c, d, e, f, g

1 digit input
4 bit input

4 bit input
 $X_3 X_2 X_1 X_0$

ON = 1
OFF = 0

Decimal	BCD	a	b	c	d	e	f	g
0	0000	1	1	1	1	1	1	0
1	0001	0	1	1	0	0	0	0
2	0010	1	1	0	1	1	0	1
3	0011	1	1	1	1	0	0	1
4	0100	0	1	1	0	0	1	1
5	0101	1	0	1	1	0	1	1
6	0110	1	0	1	1	1	1	1
7	0111	1	1	1	0	0	0	0
8	1000	1	1	1	1	1	1	1
9	1001	1	1	1	1	0	1	1

for A)

$X_3 X_2$	$X_1 X_0$	00	01	11	10
00	0	1	1	1	1
01	0	1	1	1	1
11	1	1	1	1	1
10	1	1	1	1	1

$$A = X_1 + X_3 + X_0 X_2 + X_0' X_2'$$

AND-OR

$$= (X_1' X_3' (X_0 X_2) (X_0' X_2'))$$

NAND-NAND

B:

$X_3 X_2$	$X_1 X_0$	00	01	11	10
00	1	1	1	1	1
01	1	0	1	0	0
11	1	1	1	1	1
10	1	1	1	1	1

$$B = X_3 + X_3' X_2' + X_0' X_1' + X_0 X_1$$

AND OR

$$= (X_3' (X_3 X_2) (X_0' X_1') (X_0 X_1))$$

NAND-NAND

C:

$X_3 X_2$	$X_1 X_0$	00	01	11	10
00	1	1	1	1	0
01	1	1	1	1	1
11	1	1	1	1	1
10	1	1	1	1	1

$$C = X_1' + X_3 + X_2 + X_0$$

AND OR

$$= X_1 X_3' X_2' X_0'$$

NAND-NAND

for D)

		$x_1 x_0$	x_1
$x_3 x_2$	1	0	1
	0	1	0
x_3	1	1	1
	1	1	1
		x_0	x_2

Essential prime implicants:

$$x_3, x_2'x_0', x_1x_0', x_2'x_1, x_2x_1'x_0$$

$$d = x_3 + x_2'x_0' + x_1x_0' + x_2'x_1 + x_2x_1'x_0$$

$$d = (x_3' \cdot (x_2'x_0')' \cdot (x_1x_0')' \cdot (x_2'x_1)' \cdot (x_2x_1'x_0)')'$$

for E)

		$x_1 x_0$	x_1
$x_3 x_2$	1	0	0
	0	0	0
x_3	1	0	1
	1	0	1
		x_0	x_2

Essential: $x_2'x_0', x_1x_0'$

$$e = x_2'x_0' + x_1x_0'$$

$$e = ((x_2'x_0')' \cdot (x_1x_0')')'$$

for F)

		$x_1 x_0$	x_1
$x_3 x_2$	1	0	0
	1	0	0
x_3	1	0	1
	1	1	1
		x_0	x_2

Essential: $x_2x_0', x_2x_1', x_1'x_0', x_3$

$$f = x_2x_0' + x_2x_1' + x_1'x_0' + x_3$$

$$f = ((x_2x_0') \cdot (x_2x_1')' \cdot (x_1'x_0')' \cdot x_3')'$$

$$x_1'x_2$$

for G)

		$x_1 x_0$	x_1
$x_3 x_2$	0	0	1
	1	0	1
x_3	1	1	1
	1	1	1
		x_0	x_2

Essential: $x_3, x_2'x_1, x_2x_1'$

$$g = x_3 + x_2'x_1 + x_2x_1' + (x_1x_0' \text{ or } x_2x_0')$$

$$g = (x_3' \cdot (x_2'x_1)' \cdot (x_2x_1')' \cdot (x_1x_0')')'$$