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Assignment 1

Design a Up and Down (as selected by a control line) Decade Counter using JK-Flip Flop.

Initial state					Final State				Input Given			
S	Q_4	Q_3	Q_2	Q_1	$\overrightarrow{Q_4}$	$\overrightarrow{Q_3}$	$\overrightarrow{Q_2}$	$\overrightarrow{Q_1}$	q_1	q_2	q_3	q_4
0	0	0	0	0	0	0	0	1	1	0	0	0
0	0	0	0	1	0	0	1	0	1	1	0	0
0	0	0	1	0	0	0	1	1	1	0	0	0
0	0	0	1	1	0	1	0	0	1	1	1	0
0	0	1	0	0	0	1	0	1	1	0	0	0
0	0	1	0	1	0	1	1	0	1	1	0	0
0	0	1	1	0	0	1	1	1	1	0	0	0
0	0	1	1	1	1	0	0	0	1	1	1	1
0	1	0	0	0	1	0	0	1	1	0	0	0
0	1	0	0	1	0	0	0	0	1	0	0	1
1	0	0	0	0	1	0	0	1	1	0	0	1
1	0	0	0	1	0	0	0	0	1	0	0	0
1	0	0	1	0	0	0	0	1	1	0	1	0
1	0	0	1	1	0	0	1	0	1	0	0	0
1	0	1	0	0	0	0	1	1	1	0	1	0
1	0	1	0	1	0	1	0	0	1	0	0	0
1	0	1	1	0	0	1	0	1	1	0	0	0
1	0	1	1	1	0	1	1	0	1	0	0	0
1	1	0	0	0	0	1	1	1	1	1	1	1
1	1	0	0	1	1	0	0	0	1	0	0	0

Kmaps

For S = 0;

q_2	$\bar{Q_2}\bar{Q_1}$	$\bar{Q_2}Q_1$	Q_2Q_1	$Q_2\bar{Q_1}$
$\bar{Q_4}\bar{Q_3}$	0 (0)	1 (1)	1 (3)	0 (2)
$\bar{Q_4}Q_3$	0 (4)	1 (5)	1 (7)	0 (6)
Q_4Q_3	d (12)	d (13)	d (15)	d (14)
$Q_4\bar{Q_3}$	0 (8)	0 (9)	d (11)	d (10)

$$JK \text{ for } q_2 = Q_1\bar{Q_4}$$

For S = 1,

q_2	$\bar{Q_2}\bar{Q_1}$	$\bar{Q_2}Q_1$	Q_2Q_1	$Q_2\bar{Q_1}$
$\bar{Q_4}\bar{Q_3}$	0 (0)	0 (1)	0 (3)	1 (2)
$\bar{Q_4}Q_3$	1 (4)	0 (5)	0 (7)	1 (6)
Q_4Q_3	d (12)	d (13)	d (15)	d (14)
$Q_4\bar{Q_3}$	1 (8)	0 (9)	d (11)	d (10)

$$JK \text{ for } q_2 = \bar{Q_1}Q_2 + \bar{Q_1}Q_3 + \bar{Q_1}Q_4$$

For S=0

q_3	$\bar{Q_2}\bar{Q_1}$	$\bar{Q_2}Q_1$	Q_2Q_1	$Q_2\bar{Q_1}$
$\bar{Q_4}\bar{Q_3}$	0	0	1	
$\bar{Q_4}Q_3$	0	0	1	0
Q_4Q_3	d	d	d	d
$Q_4\bar{Q_3}$	0	0	d	d

$$JK \text{ for } q_3 = Q_1Q_2$$

For S=1

q_3	$\bar{Q_2}\bar{Q_1}$	$\bar{Q_2}Q_1$	Q_2Q_1	$Q_2\bar{Q_1}$
$\bar{Q_4}\bar{Q_3}$	0	0	0	0
$\bar{Q_4}Q_3$	1	0	0	0
Q_4Q_3	d	d	d	d
$Q_4\bar{Q_3}$	1	0	d	d

$$JK \text{ for } q_3 = \bar{Q_1}\,\bar{Q_2}\,Q_3 + \bar{Q_1}Q_2Q_4$$

q_4	$\bar{Q_2}\bar{Q_1}$	$\bar{Q_2}Q_1$	Q_2Q_1	$Q_2\bar{Q_1}$
$\bar{Q_4}\bar{Q_3}$	0	0	0	0
$\bar{Q_4}Q_3$	0	0	1	0
Q_4Q_3	d	d	d	d
$Q_4\bar{Q_3}$	0	1	d	d

$$JK \text{ for } q_4 = Q_1Q_2Q_3 + Q_1Q_4$$

q_4	$\bar{Q_2}\bar{Q_1}$	$\bar{Q_2}Q_1$	Q_2Q_1	$Q_2\bar{Q_1}$
$\bar{Q_4}\bar{Q_3}$	1	0	0	0
$\bar{Q_4}Q_3$	0	0	0	0
Q_4Q_3	d	d	d	d
$Q_4\bar{Q_3}$	1	0	d	d

$$JK \text{ for } q_4 = \bar{Q_1}\,\bar{Q_2}\,Q_3$$

Clock

UP(0) /DOWN(1)

S x1

x4

x1

Clear