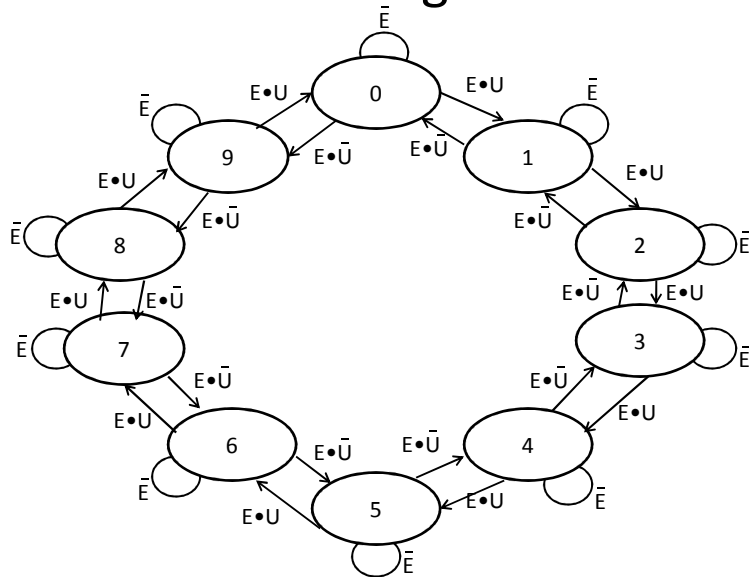


## Design of an Up/Down Decade Counter

State Diagram



Enable	Up	Count	Next
0	0	0000	0000
0	0	0001	0001
0	0	0010	0010
0	0	0011	0011
0	0	0100	0100
0	0	0101	0101
0	0	0110	0110
0	0	0111	0111
0	0	1000	1000
0	0	1001	1001
0	0	1010	XXXX
0	0	1011	XXXX
0	0	1100	XXXX
0	0	1101	XXXX
0	0	1110	XXXX
0	0	1111	XXXX

Enable	Up	Count	Next
0	1	0000	0000
0	1	0001	0001
0	1	0010	0010
0	1	0011	0011
0	1	0100	0100
0	1	0101	0101
0	1	0110	0110
0	1	0111	0111
0	1	1000	1000
0	1	1001	1001
0	1	1010	XXXX
0	1	1011	XXXX
0	1	1100	XXXX
0	1	1101	XXXX
0	1	1110	XXXX
0	1	1111	XXXX

Enable	Up	Count	Next
1	0	0000	1001
1	0	0001	0000
1	0	0010	0001
1	0	0011	0010
1	0	0100	0011
1	0	0101	0100
1	0	0110	0101
1	0	0111	0110
1	0	1000	0111
1	0	1001	1000
1	0	1010	XXXX
1	0	1011	XXXX
1	0	1100	XXXX
1	0	1101	XXXX
1	0	1110	XXXX
1	0	1111	XXXX

Enable	Up	Count	Next
1	1	0000	0001
1	1	0001	0010
1	1	0010	0011
1	1	0011	0100
1	1	0100	0101
1	1	0101	0110
1	1	0110	0111
1	1	0111	1000
1	1	1000	1001
1	1	1001	0000
1	1	1010	XXXX
1	1	1011	XXXX
1	1	1100	XXXX
1	1	1101	XXXX
1	1	1110	XXXX
1	1	1111	XXXX

These locations for A asserted

0	0	0	0
0	0	0	0
0	0	0	0
0	0	0	0

0	0	0	0
0	0	0	0
0	0	0	0
0	0	0	0

0	0	0	0
0	0	0	0
0	0	0	0
0	0	0	0

0	0	0	0
0	0	0	0
0	0	0	0
0	0	0	0

These locations for B asserted

0	0	0	0
0	0	0	0
0	0	0	0
0	0	0	0

0	0	0	0
0	0	0	0
0	0	0	0
0	0	0	0

0	0	0	0
0	0	0	0
0	0	0	0
0	0	0	0

0	0	0	0
0	0	0	0
0	0	0	0
0	0	0	0

These locations for C asserted

0	0	0	0
0	0	0	0
0	0	0	0
0	0	0	0

0	0	0	0
0	0	0	0
0	0	0	0
0	0	0	0

0	0	0	0
0	0	0	0
0	0	0	0
0	0	0	0

0	0	0	0
0	0	0	0
0	0	0	0
0	0	0	0

These locations for D asserted

0	0	0	0
0	0	0	0
0	0	0	0
0	0	0	0

0	0	0	0
0	0	0	0
0	0	0	0
0	0	0	0

0	0	0	0
0	0	0	0
0	0	0	0
0	0	0	0

0	0	0	0
0	0	0	0
0	0	0	0
0	0	0	0

These locations for Up asserted

0	0	0	0
0	0	0	0
0	0	0	0
0	0	0	0

0	0	0	0
0	0	0	0
0	0	0	0
0	0	0	0

0	0	0	0
0	0	0	0
0	0	0	0
0	0	0	0

0	0	0	0
0	0	0	0
0	0	0	0
0	0	0	0

These locations for Enable asserted

0	0	0	0
0	0	0	0
0	0	0	0
0	0	0	0

0	0	0	0
0	0	0	0
0	0	0	0
0	0	0	0

0	0	0	0
0	0	0	0
0	0	0	0
0	0	0	0

0	0	0	0
0	0	0	0
0	0	0	0
0	0	0	0

0	4	12	8
1	5	13	9
3	7	15	11
2	6	14	10

40	44	36	32
41	45	37	33
43	47	39	35
42	46	38	34

18	22	30	26
19	23	31	27
17	21	29	25
16	20	28	24

58	62	54	50
59	63	55	51
57	61	53	49
56	60	52	48

Map for A (LSB)

0	0	X	0
1	1	X	1
1	1	X	X
0	0	X	X

1	X	1	1
0	X	0	0
X	X	0	0
X	X	1	1

0	0	X	X
1	1	X	X
1	1	X	1
0	0	X	0

X	X	1	1
X	X	0	0
0	X	0	0
1	X	1	1

$$A \bullet \overline{E} + \overline{A} \bullet E$$

Map for B

0	0	X	0
0	0	X	0
1	1	X	X
1	1	X	X

1	X	1	0
0	X	0	0
X	X	1	1
X	X	0	0

1	1	X	X
1	1	X	X
0	0	X	0
0	0	X	0

X	X	1	1
X	X	0	0
0	X	1	1
0	X	0	0

$$E \cdot UP \cdot \bar{D} \cdot \bar{B} \cdot A + E \cdot \bar{UP} \cdot C \cdot \bar{B} \cdot \bar{A} + E \cdot \bar{UP} \cdot D \cdot \bar{A} + \\ UP \cdot B \cdot \bar{A} + \bar{UP} \cdot B \cdot A + \bar{E} \cdot B$$

Map for C

0	1	X	0
0	1	X	0
0	1	X	X
0	1	X	X

1	X	0	0
0	X	1	0
X	X	1	0
X	X	1	0

0	1	X	X
0	1	X	X
0	1	X	0
0	1	X	0

X	X	1	0
X	X	0	1
0	X	1	0
0	X	1	0

$$E \cdot \bar{UP} \cdot D \cdot \bar{B} \cdot \bar{A} + E \cdot UP \cdot \bar{C} \cdot B \cdot A + C \cdot B \cdot \bar{A} + \\ \bar{UP} \cdot C \cdot A + \bar{E} \cdot \bar{D} \cdot C + UP \cdot C \cdot \bar{B}$$



Map for D (MSB)

0	0	X	1
0	0	X	1
0	0	X	X
0	0	X	X

0	X	0	1
1	X	0	0
X	X	0	0
X	X	0	0

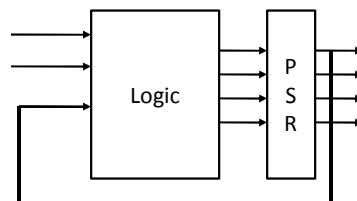
  

0	0	X	X
0	0	X	X
0	0	X	1
0	0	X	1

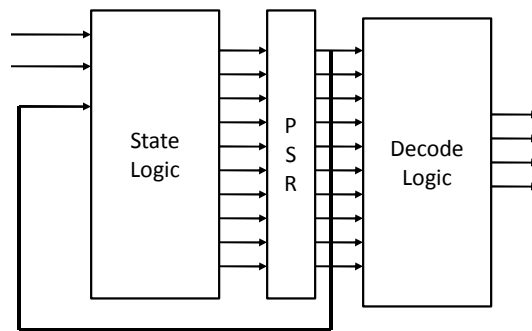
X	X	0	0
X	X	1	0
0	X	0	0
1	X	0	0

$$E \bullet \overline{UP} \bullet \overline{D} \bullet \overline{C} \bullet \overline{B} \bullet \overline{A} + E \bullet UP \bullet C \bullet B \bullet A + \\ UP \bullet D \bullet \overline{A} + \overline{UP} \bullet D \bullet A + \overline{E} \bullet D$$

## Implementation Method for Clocked Sequential System



## Another Implementation Method for Clocked Sequential System



## State Logic for One-Hot Method

