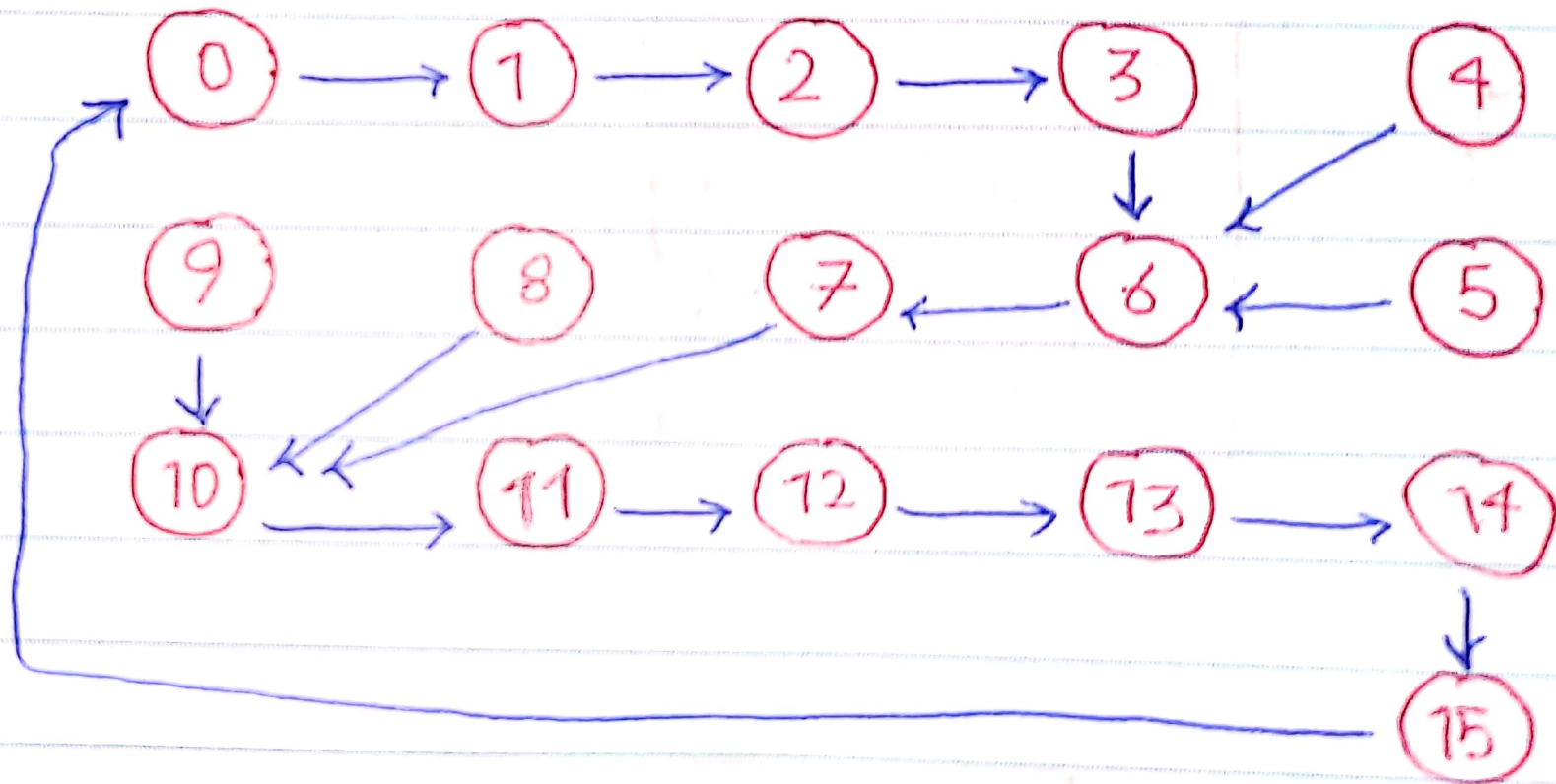


Design of Unusual Counter

State Diagram



16 states \Rightarrow 4 JK-flipflop

Current State	Next State					Output
y3 y2 y1 y0	Y3 Y2 Y1 Y0	J3 K3	J2 K2	J1 K1	J0 K0	z3 z2 z1 z0
0 0 0 0	0 0 0 1	0 d	0 d	0 d	1 d	0 0 0 0
0 0 0 1	0 0 1 0	0 d	0 d	1 d	d 1	0 0 0 1
0 0 1 0	0 0 1 1	0 d	0 d	d 0	1 d	0 0 1 0
0 0 1 1	0 1 1 0	0 d	1 d	d 0	d 1	0 0 1 1
0 1 0 0	0 1 1 0	0 d	d 0	1 d	0 d	0 1 0 0
0 1 0 1	0 1 1 0	0 d	d 0	1 d	d 1	0 1 0 1
0 1 1 0	0 1 1 1	0 d	d 0	d 0	1 d	0 1 1 0
0 1 1 1	1 0 1 0	1 d	d 1	d 0	d 1	0 1 1 1
1 0 0 0	1 0 1 0	d 0	0 d	1 d	0 d	1 0 0 0
1 0 0 1	1 0 1 0	d 0	0 d	1 d	d 1	1 0 0 1
1 0 1 0	1 0 1 1	d 0	0 d	d 0	1 d	1 0 1 0
1 0 1 1	1 1 0 0	d 0	1 d	d 1	d 1	1 0 1 1
1 1 0 0	1 1 0 1	d 0	d 0	0 d	1 d	1 1 0 0
1 1 0 1	1 1 1 0	d 0	d 0	1 d	d 1	1 1 0 1
1 1 1 0	1 1 1 1	d 0	d 0	d 0	1 d	1 1 1 0
1 1 1 1	0 0 0 0	d 1	d 1	d 1	d 1	1 1 1 1

Karnaugh Map (using jk-flipflop)

J_0

$y_3 y_2$	$y_3 \bar{y}_2$	$\bar{y}_3 y_2$	$\bar{y}_3 \bar{y}_2$
$y_1 y_0$	1	d	1
$y_1 \bar{y}_0$	d	d	d
$\bar{y}_1 y_0$	d	d	d
$\bar{y}_1 \bar{y}_0$	1	1	1

y_3

y_2

y_1

y_0

$$J_0 = y_1 + y_3 y_2 + \bar{y}_3 \bar{y}_2$$

K_0

$y_3 y_2$	$y_3 \bar{y}_2$	$\bar{y}_3 y_2$	$\bar{y}_3 \bar{y}_2$
$y_1 y_0$	d	d	d
$y_1 \bar{y}_0$	1	1	1
$\bar{y}_1 y_0$	1	1	1
$\bar{y}_1 \bar{y}_0$	d	d	d

y_3

y_2

y_1

y_0

$$K_0 = y_0$$

J_1

$y_3 y_2$	$y_3 \bar{y}_2$	$\bar{y}_3 y_2$	$\bar{y}_3 \bar{y}_2$
$y_1 y_0$		1	
$y_1 \bar{y}_0$	1	1	1
$\bar{y}_1 y_0$	d	d	d
$\bar{y}_1 \bar{y}_0$	d	d	d

y_3

y_2

y_1

y_0

$$J_1 = y_0 + y_3 \bar{y}_2 + \bar{y}_3 y_2$$

K_1

$y_3 y_2$	$y_3 \bar{y}_2$	$\bar{y}_3 y_2$	$\bar{y}_3 \bar{y}_2$
$y_1 y_0$	d	d	d
$y_1 \bar{y}_0$	d	d	d
$\bar{y}_1 y_0$			1
$\bar{y}_1 \bar{y}_0$			1

y_3

y_2

y_1

y_0

$$K_1 = y_3 y_0$$

J_2

$$y_1 \left(\begin{array}{c|c|c|c} & & & \\ & d & d & \\ & d & d & \\ \hline & 1 & d & d & 1 \\ & d & d & & \end{array} \right) y_0$$
 $J_2 = y_1 y_0$

K_2

$$y_0 \left(\begin{array}{c|c|c|c} & & & \\ & d & & d \\ & d & & d \\ \hline & d & 1 & 1 & d \\ & d & & & d \end{array} \right) y_1$$
 $K_2 = J_2$

J_3

$$y_0 \left(\begin{array}{c|c|c|c} & & & \\ & & d & d \\ & & d & d \\ \hline & & 1 & d & d \\ & & d & d & \end{array} \right) y_1$$
 $J_3 = y_2 y_1 y_0$

K_3

$$y_0 \left(\begin{array}{c|c|c|c} & & & \\ & d & d & \\ & d & d & \\ \hline & d & d & 1 \\ & d & d & \end{array} \right) y_1$$
 $K_3 = J_3$

Two-Digit decimal to two 7-seg

 $y_3 y_2 y_1 y_0$

0 0 0 0

0 0 0 1

0 0 1 0

0 0 1 1

0 1 0 0

0 1 0 1

0 1 1 0

0 1 1 1

1 0 0 0

1 0 0 1

1 0 1 0

1 0 1 1

1 1 0 0

1 1 0 1

1 1 1 0

1 1 1 1

 $Z_3 Z_2 Z_1 Z_0$

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 1

0 0 0 1

0 0 0 1

0 0 0 1

0 0 0 1

0 0 0 1

0 0 0 1

 $S_3 S_2 S_1 S_0$

0 0 0 0

0 0 0 1

0 0 1 0

0 0 1 1

0 1 0 0

0 1 0 1

0 1 1 0

0 1 1 1

1 0 0 0

1 0 0 1

0 0 0 0

0 0 0 1

0 0 1 0

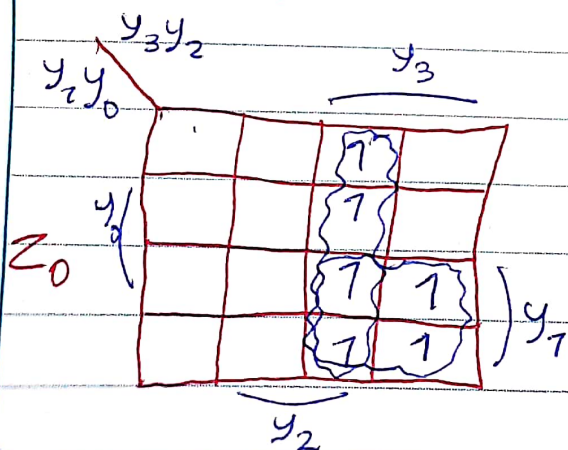
0 0 1 1

0 1 0 0

0 1 0 1

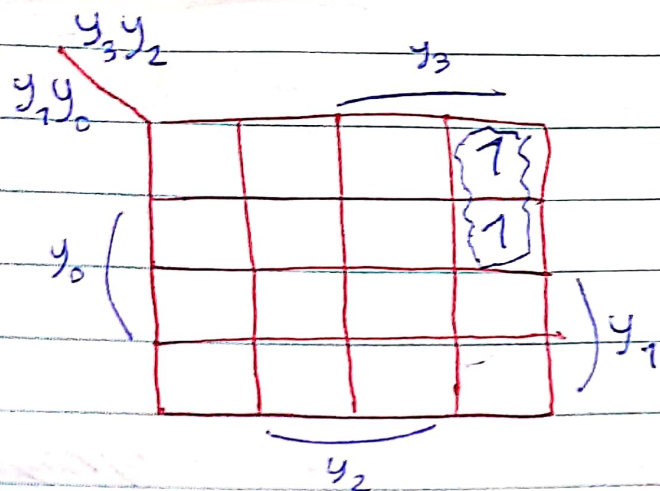
$$Z_3 = Z_2 = Z_1 = 0$$

Karnaugh Map



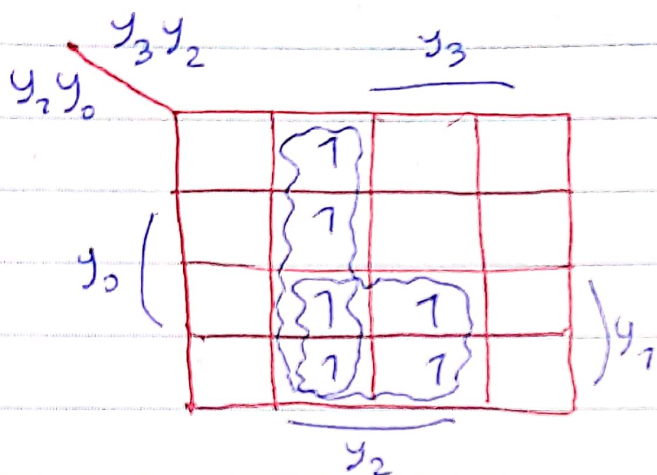
$$Z_0 = y_3 y_2 + y_3 y_1$$

S_3



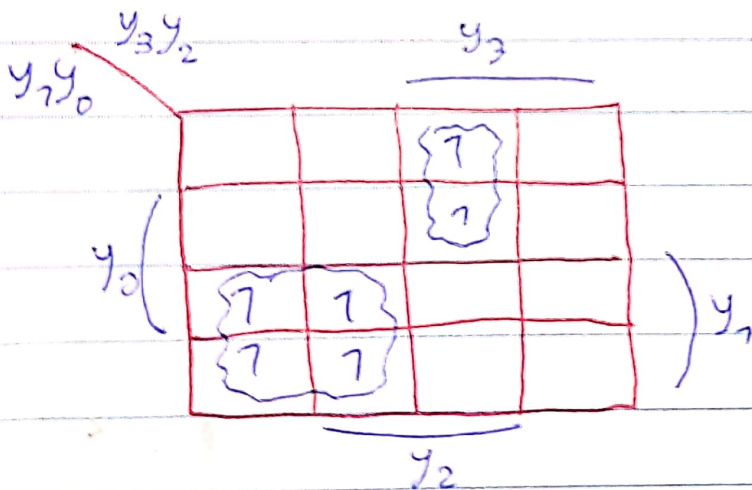
$$S_3 = y_3 \bar{y}_2 \bar{y}_1$$

S_2



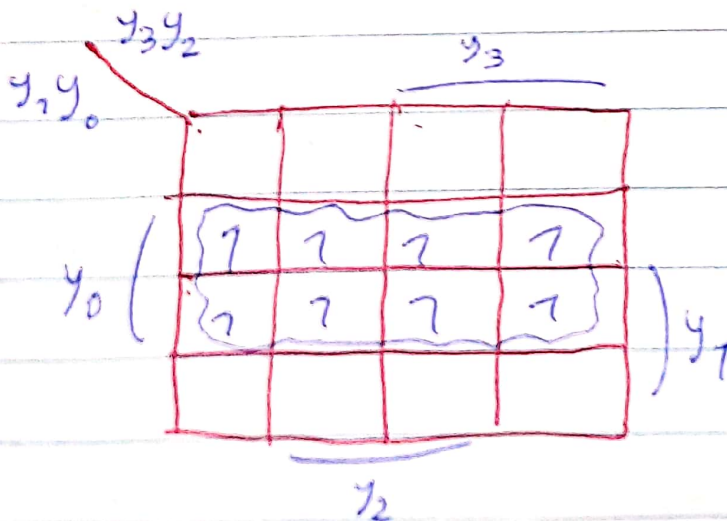
$$S_2 = \bar{y}_3 y_2 + y_2 y_1$$

S_1



$$S_1 = \bar{y}_3 y_1 + y_3 \bar{y}_2 \bar{y}_1$$

S_0



$$S_0 = y_0$$