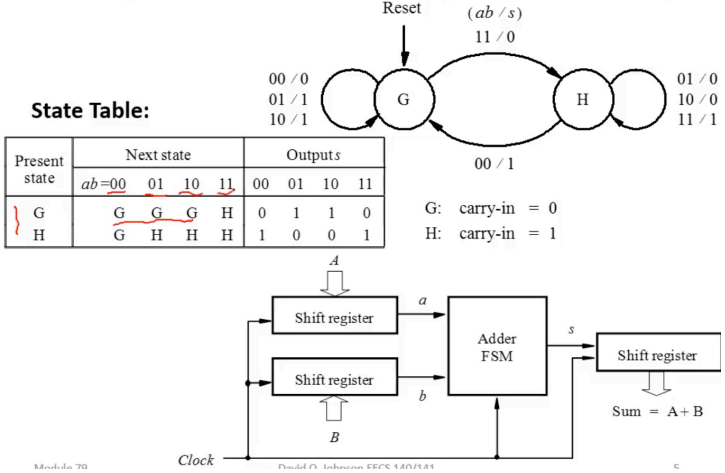
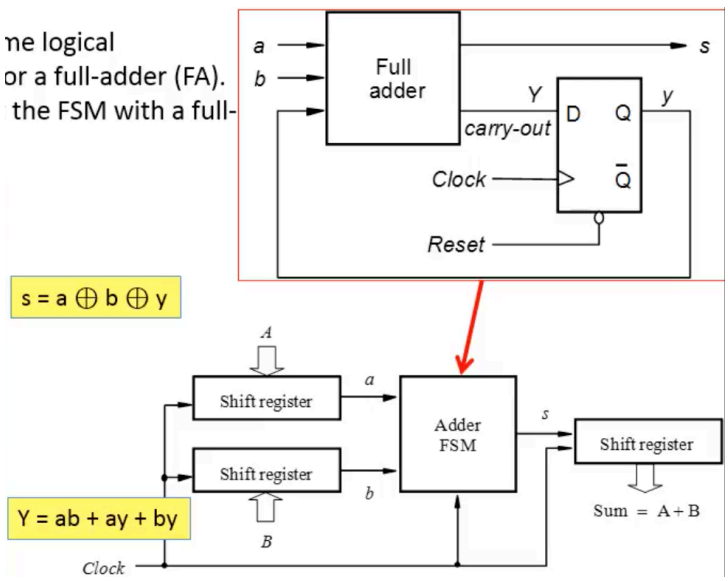


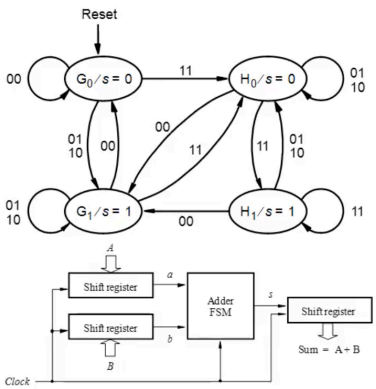
State Table:

Present state	Next state				Output s			
	ab = 00	01	10	11	00	01	10	11
G	G	G	G	H	0	1	1	0
H	G	H	H	H	1	0	0	1

G: carry-in = 0
H: carry-in = 1

Present state	Next state				Output			
	ab = 00	01	10	11	00	01	10	11
y	Y				s			
0	0	0	0	1	0	1	1	0
1	0	1	1	1	1	0	0	1

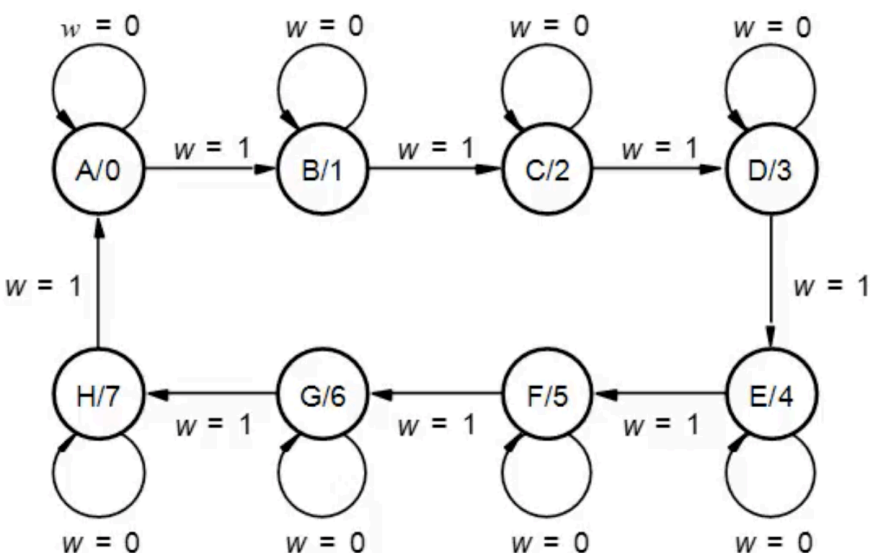




Present state	Next state				Output
	ab = 00	01	10	11	s
G_0	G_0	G_1	G_1	H_0	0
G_1	G_0	G_1	G_1	H_0	1
H_0	G_1	H_0	H_0	H_1	0
H_1	G_1	H_0	H_0	H_1	1

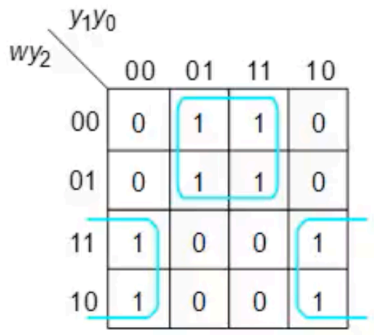
Present state y_2y_1	Next state ab = 00	01	10	11	Output s
	Y_2Y_1				
00	00	01	01	10	0
01	00	01	01	10	1
10	01	10	10	11	0
11	01	10	10	11	1

FSM Counter

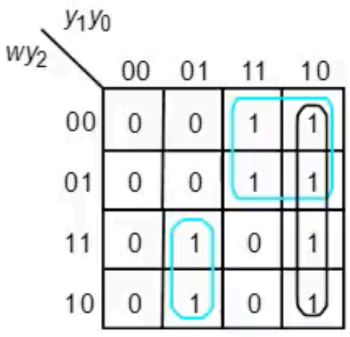


Present state	Next state		Output
	w = 0	w = 1	
A	A	B	0
B	B	C	1
C	C	D	2
D	D	E	3
E	E	F	4
F	F	G	5
G	G	H	6
H	H	A	7

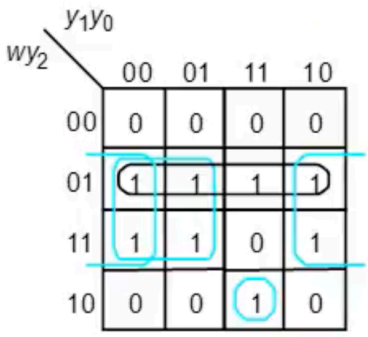
	Present state $y_2y_1y_0$	Next state $w = 0$ $Y_2Y_1Y_0$	Next state $w = 1$ $Y_2Y_1Y_0$	Count $z_2z_1z_0$
A	000	000	001	000
B	001	001	010	001
C	010	010	011	010
D	011	011	100	011
E	100	100	101	100
F	101	101	110	101
G	110	110	111	110
H	111	111	000	111



$Y_0 = \bar{w}y_0 + w\bar{y}_0$



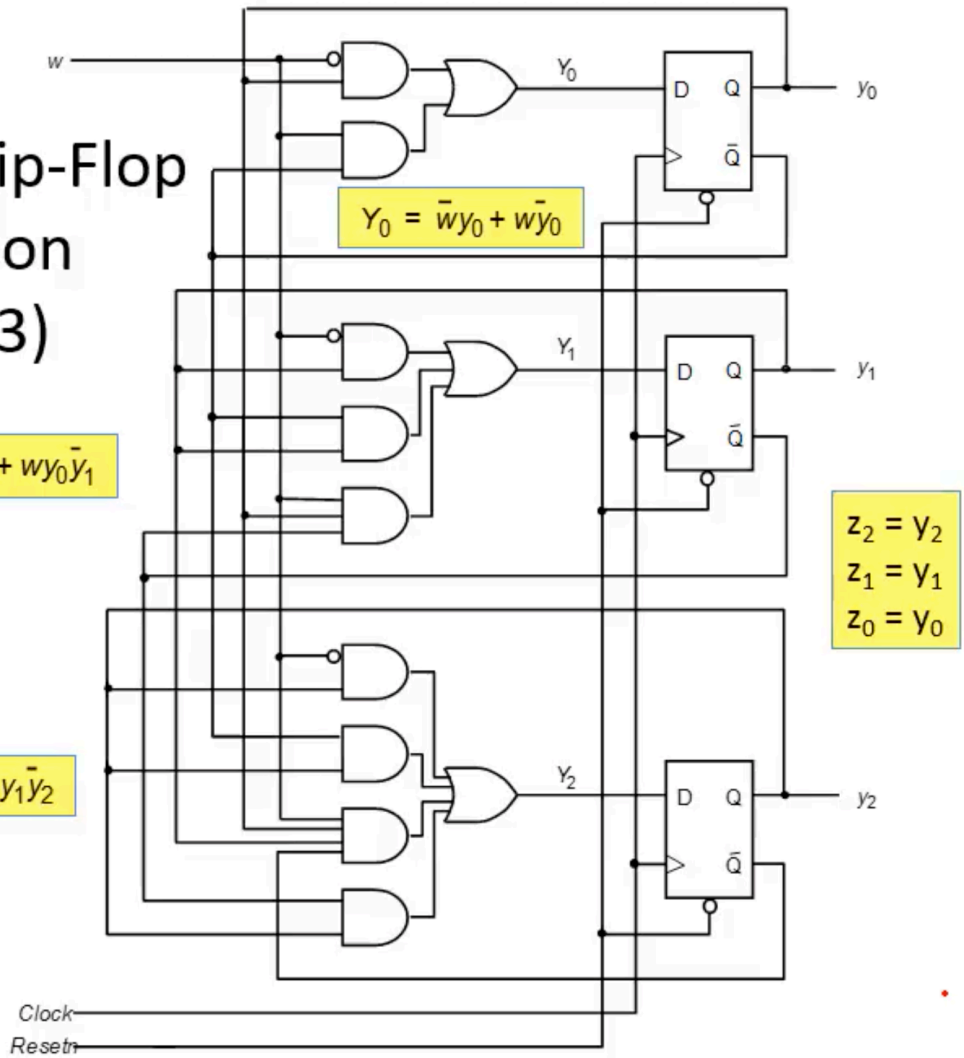
$Y_1 = \bar{w}y_1 + y_1\bar{y}_0 + wy_0\bar{y}_1$



$Y_2 = \bar{w}y_2 + \bar{y}_0y_2 + \bar{y}_1y_2 + wy_0y_1\bar{y}_2$

$z_2 = y_2$
$z_1 = y_1$
$z_0 = y_0$

Counter FSM D Flip-Flop Implementation (Section 8.7.3)



$Y_0 = \bar{w}y_0 + w\bar{y}_0$

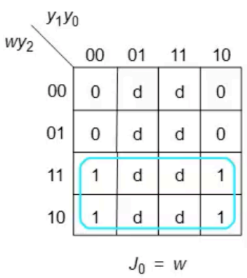
$Y_1 = \bar{w}y_1 + y_1\bar{y}_0 + wy_0\bar{y}_1$

$Y_2 = \bar{w}y_2 + \bar{y}_0y_2 + \bar{y}_1y_2 + wy_0y_1\bar{y}_2$

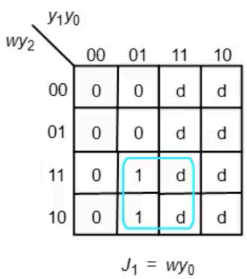
$z_2 = y_2$
$z_1 = y_1$
$z_0 = y_0$

- Using JK flip-flops requires derivation of inputs J and K for each flip-flop.
- If a flip-flop in state 0 is to remain in state 0, then J = 0 and K = d (don't care)
- If a flip-flop in state 0 is to change to state 1, then J = 1 and K = d
- If a flip-flop in state 1 is to remain in state 1, then J = d and K = 0
- If a flip-flop in state 1 is to change to state 0, then J = d and K = 1

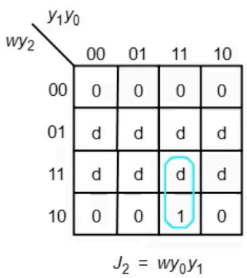
	Present state $y_2y_1y_0$	Flip-flop inputs								Count $z_2z_1z_0$
		$w = 0$				$w = 1$				
		$Y_2Y_1Y_0$	J_2K_2	J_1K_1	J_0K_0	$Y_2Y_1Y_0$	J_2K_2	J_1K_1	J_0K_0	
A	000	000	0d	0d	0d	001	0d	0d	1d	000
B	001	001	0d	0d	d0	010	0d	1d	d1	001
C	010	010	0d	d0	0d	011	0d	d0	1d	010
D	011	011	0d	d0	d0	100	1d	d1	d1	011
E	100	100	d0	0d	0d	101	d0	0d	1d	100
F	101	101	d0	0d	d0	110	d0	1d	d1	101
G	110	110	d0	d0	0d	111	d0	d0	1d	110
H	111	111	d0	d0	d0	000	d1	d1	d1	111



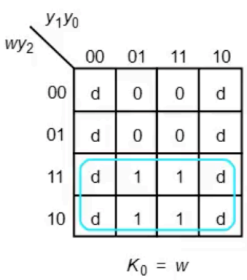
$J_0 = w$



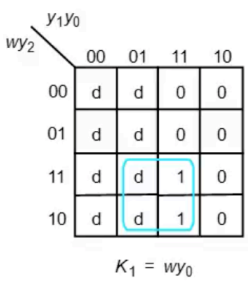
$J_1 = wy_0$



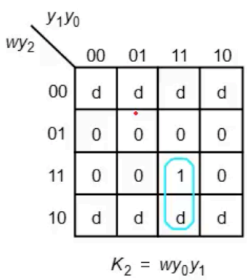
$J_2 = wy_0y_1$



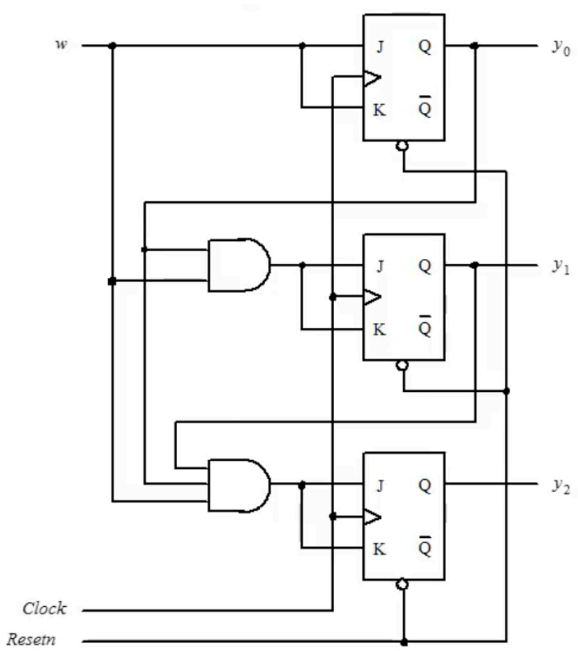
$K_0 = w$



$K_1 = wy_0$



$K_2 = wy_0y_1$



Count any sequence

- The counting sequence is:
  0, 4, 2, 6, 1, 5, 3, 7, 0, 4, ...
- Count is represented directly by flip-flop outputs themselves, without using any extra gates: $Q_2Q_1Q_0$

Present state	Next state	Output $z_2z_1z_0$
A	B	000
B	C	100
C	D	010
D	E	110
E	F	001
F	G	101
G	H	011
H	A	111

Present state $y_2y_1y_0$	Next state $Y_2Y_1Y_0$	Output $z_2z_1z_0$
000	100	000
100	010	100
010	110	010
110	001	110
001	101	001
101	011	101
011	111	011
111	000	111

$D_2 = Y_2 = !y_2$

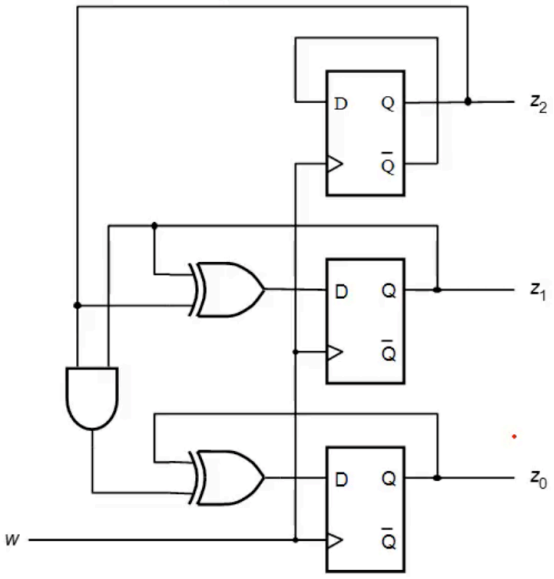
$D_1 = Y_1 = y_1 \oplus y_2$

$D_0 = Y_0 = y_0!y_1 + y_0!y_2 + !y_0y_1y_2$
$= y_0(!y_1 + !y_2) + !y_0y_1y_2$
$= y_0!(y_1y_2) + !y_0(y_1y_2)$
$= y_0 \oplus (y_1y_2)$

$z_2 = y_2$

$z_1 = y_1$

$z_0 = y_0$



with D Flip-Flops

with J Flip-Flops

Design a counter that counts pulses on line w and outputs the count in the sequence:
0, 2, 1, 3, 0, 2 ...
Use JK flip-flops.

Present state	Next state	Output z_1z_0
A	B	0 0
B	C	1 0
C	D	0 1
D	A	1 1

Present state y_1y_0	Flip-flop inputs J_1K_1	J_0K_0	Output z_1z_0
0 0	1 d	0 d	0 0
1 0	d 1	1 d	1 0
0 1	1 d	d 0	0 1
1 1	d 1	d 1	1 1

$J_1 = K_1 = 1$
$J_0 = K_0 = y_1$
$z_1 = y_1$
$z_0 = y_0$