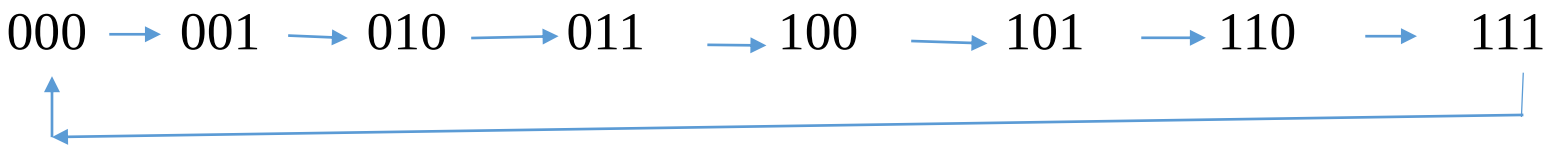
Counters

Modules of a counter is defined as the number of clock pulses required to obtain initial states of the counter.

Mod-8 Counter

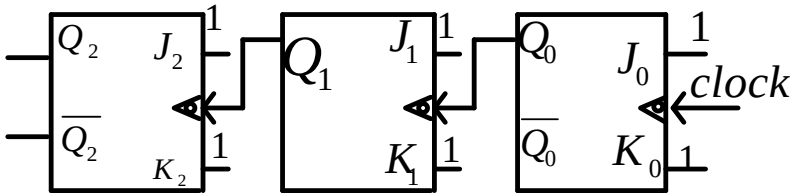


Q_2	Q_1	Q_0	clock
0	0	0	Initial state
0	0	1	1
0	1	0	2
0	1	1	3
1	0	0	4
1	0	1	5
1	1	0	6
1	1	1	7
0	0	0	8

From above table it can be observed that

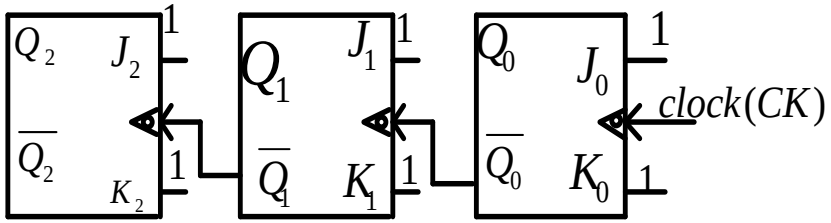
- Q_0 changes at every clock cycle
- Q_1 changes when and only when Q_o changes from 1 to 0
- Q_2 changes when and only when Q_1changes from 1 to 0

Mod-8 UP counter circuit diagram

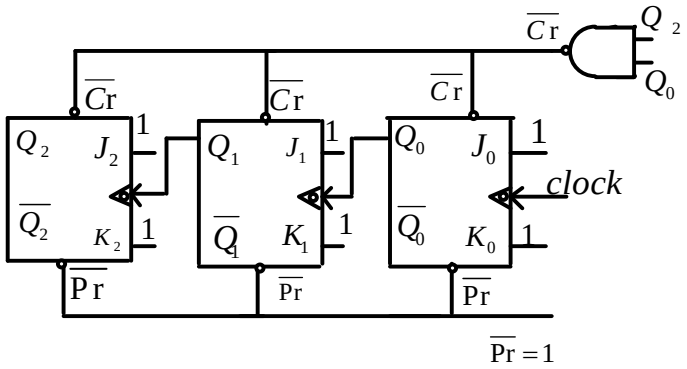


As the clock is different from different FF, it is called as asynchronous or ripple Counter

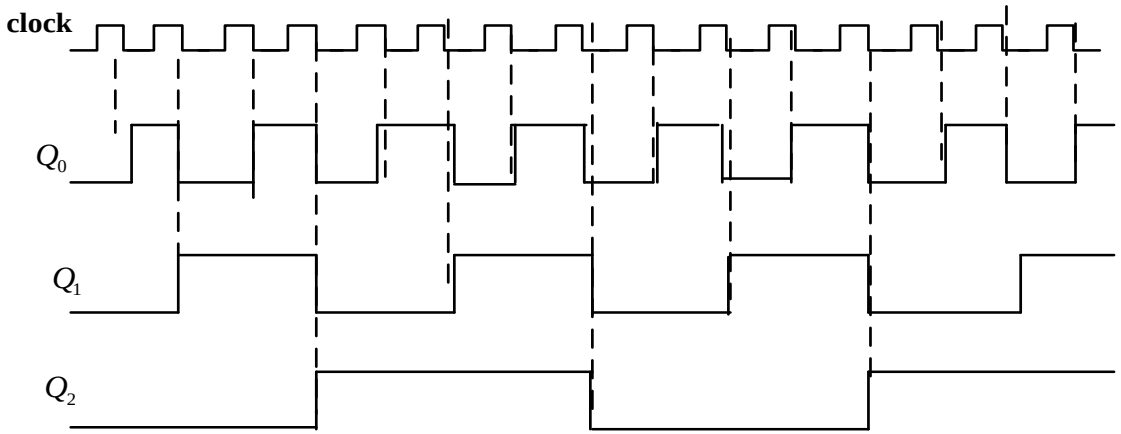
Mod-8 DOWN Counter



Mod-5 ripple Counter



Timing diagram for Mod-8 UP Counter



If clock frequency is ‘f’ the frequency of Q_0 is f /2, Q_1 f /4 and Q_2 is f \8

Excitation table

- If specifics the inputs required for a given change of state

Excitation table of JK flip flop

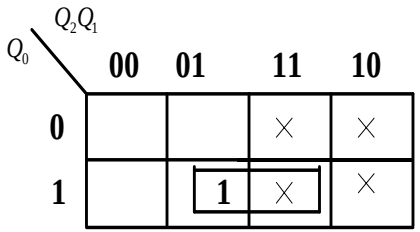
Q_n	Q_{n+1}	J	K
0	0	0	X
0	1	1	X
1	0	X	1
1	1	X	0

Design of Mod-8 synchronous Counter

Where ‘d’ represents don’t care.

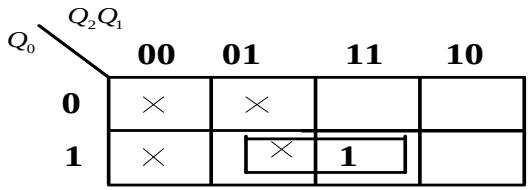
Present State	Next State	J_2K_2	J_1K_1	J_0K_0
000	111	1 d	1 d	1 d
001	000	0 d	0 d	d 1
010	001	0 d	d 1	1 d
011	010	0 d	d 0	d 1
100	011	d 1	1 d	1 d
101	100	d 0	0 d	d 1
110	101	d 0	d 1	1 d
111	110	d 0	d 0	d 1

$J_2 = \sum m(3) + \sum d(4 \text{ to } 7)$



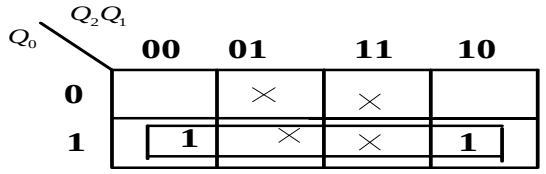
$\therefore J_2 = Q_1Q_0$

$\therefore K_2 = \sum m(7) + \sum d(0,1,2,3)$



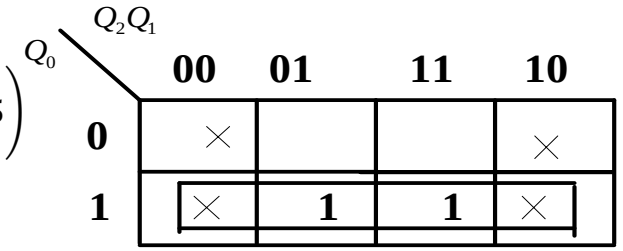
$\therefore K_2 = Q_1Q_0$

$\therefore J_1 = \sum m(1,5) + \sum d(2,3,6,7)$



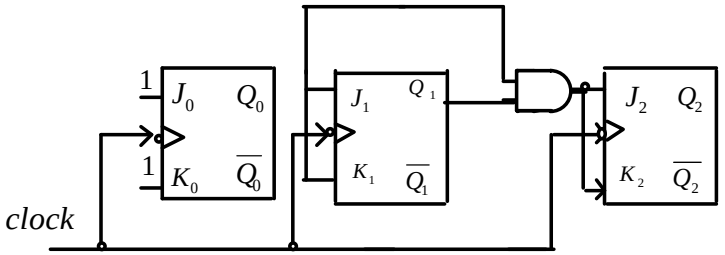
$\therefore J_1 = Q_0$

$\therefore K_1 = \sum m(3,7) + \sum d(0,1,4,5)$



$K_1 = 0$

Circuit diagram



In synchronous Counters clock is common to all the flip-flop

Analysis of synchronous Counter

$J_2 = K_2 = Q_1 Q_0$; $J_1 = K_1 = Q_0$; $J_0 = K_0 = 1$

Present state			FF Input function						Next state		
Q_2	Q_1	Q_0	J_2	K_2	J_1	K_1	J_0	K_0	Q_2	Q_1	Q_0
0	0	0	0	0	0	0	1	1	0	0	1
0	0	1	0	0	1	1	1	1	0	1	0
0	1	0	0	0	0	0	1	1	0	1	1
0	1	1	1	1	1	1	1	1	1	0	0
1	0	0	0	0	0	0	1	1	1	0	1
1	0	1	0	0	1	1	1	1	1	1	0
1	1	0	0	0	0	0	1	1	1	1	1
1	1	1	1	1	1	1	1	1	0	0	0

Hence, this a Mod-8 Counter