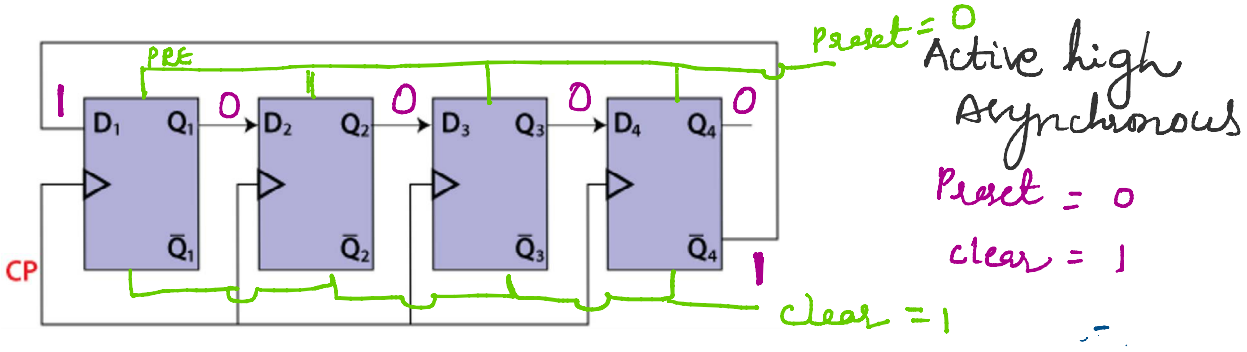
Johnson counter

The **Johnson counter** is similar to the **Ring counter**. The only difference between the **Johnson counter** and the **ring counter** is that the outcome of the last flip flop is passed to the first flip flop as an input. But in **Johnson counter**, the inverted outcome Q' of the last flip flop is passed as an input. The remaining work of the **Johnson counter** is the same as a **ring counter**. The **Johnson counter** is also referred to as the **Creeping counter**.
In Johnson counter

- No. of states in Johnson counter = No. of flip-flop used(n)
- Number of used states=2n

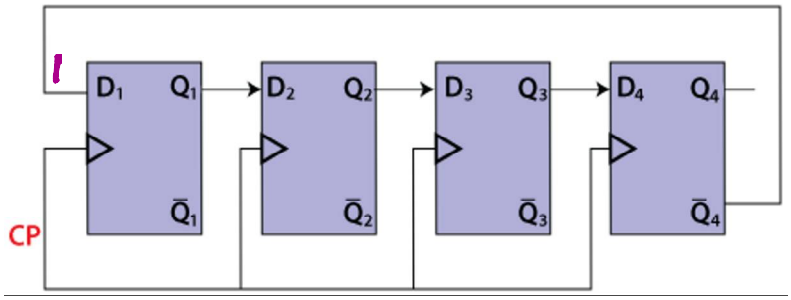
Below is the diagram of the 4-bit Johnson counter. Like Ring counter, four D flip flops are used in the 4-bit Johnson counter, and the same clock pulse is passed to all the input of the flip flops.



D1 = $\overline{Q4}$	clock	Q1	Q2	Q3	Q4
1	No clock	0	0	0	0 → Asynchronous i/p

First Clock pulse

+ve triggered



$D_1 = \bar{Q}_4 = 1 \rightarrow Q_1 = 1$

$D_2 = Q_1 = 0 \rightarrow Q_2 = 0$

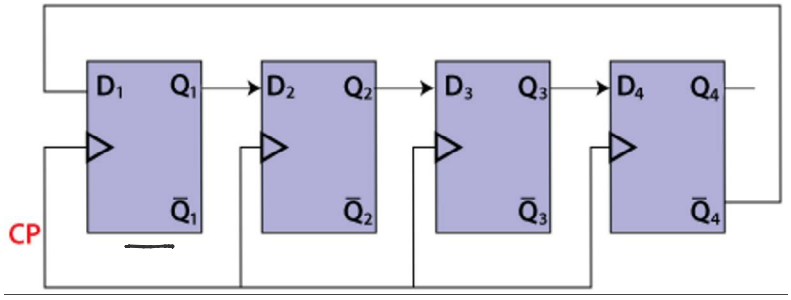
$D_3 = Q_2 = 0 \rightarrow Q_3 = 0$

$D_4 = Q_3 = 0 \rightarrow Q_4 = 0$

clock	D1 = $\bar{Q}4$	Q1	Q2	Q3	Q4
No clock	1	0	0	0	0
1st	1	1	0	0	0

$\bar{Q}_4$

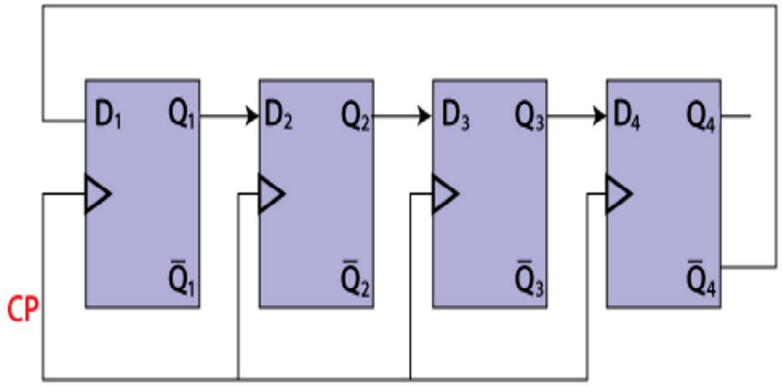
Second Clock pulse



clock	D1 = $\bar{Q}4$	Q1	Q2	Q3	Q4
1st	1	1	0	0	0
2nd	1	1	1	0	0

$\bar{Q}_4$

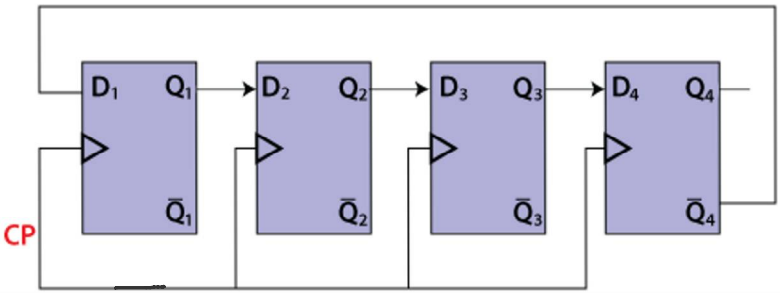
Third Clock pulse



clock	D1 = $\overline{Q4}$	Q1	Q2	Q3	Q4
2nd	1	1	1	0	0
3rd	1	1	1	1	0

$\overline{Q_4}$ = 1

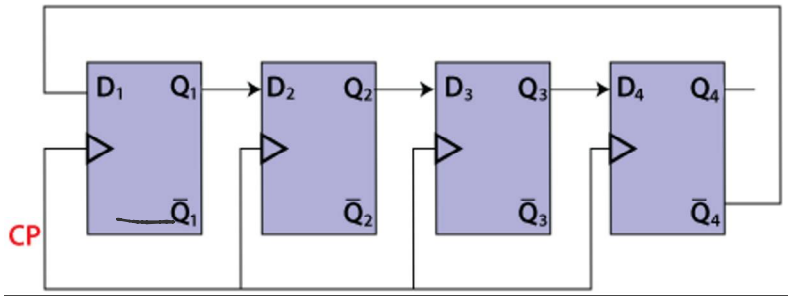
Fourth Clock pulse



clock	D1 = $\overline{Q4}$	Q1	Q2	Q3	Q4
3 rd	1	1	1	1	0
4 th	0	1	1	1	1

$\overline{Q_4}$ = 0

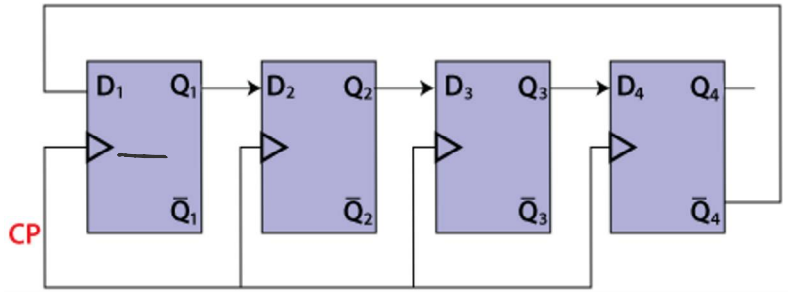
Fifth Clock pulse



clock	D1 = $\overline{Q4}$	Q1	Q2	Q3	Q4
4 th	0	1	1	1	1
5 th	0	0	1	1	1

$\overline{Q_4}$

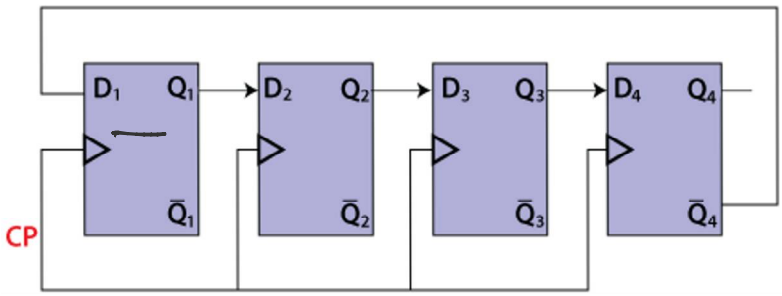
Sixth Clock pulse



clock	D1 = $\overline{Q4}$	Q1	Q2	Q3	Q4
5 th	0	0	1	1	1
6 th	0	0	0	1	1

$\overline{Q_4}$

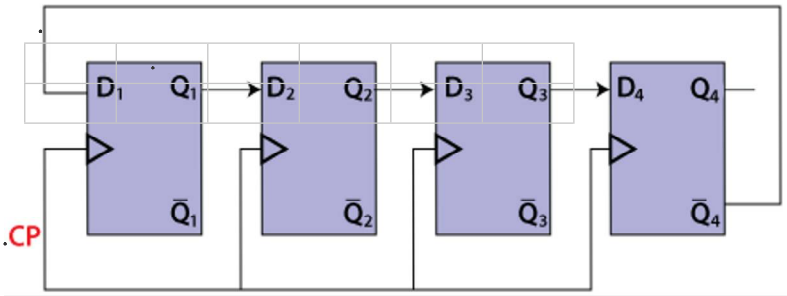
Seventh Clock pulse



clock	D1 = $\overline{Q4}$	Q1	Q2	Q3	Q4
6 th	0	0	0	1	1
7 th	0	0	0	0	1

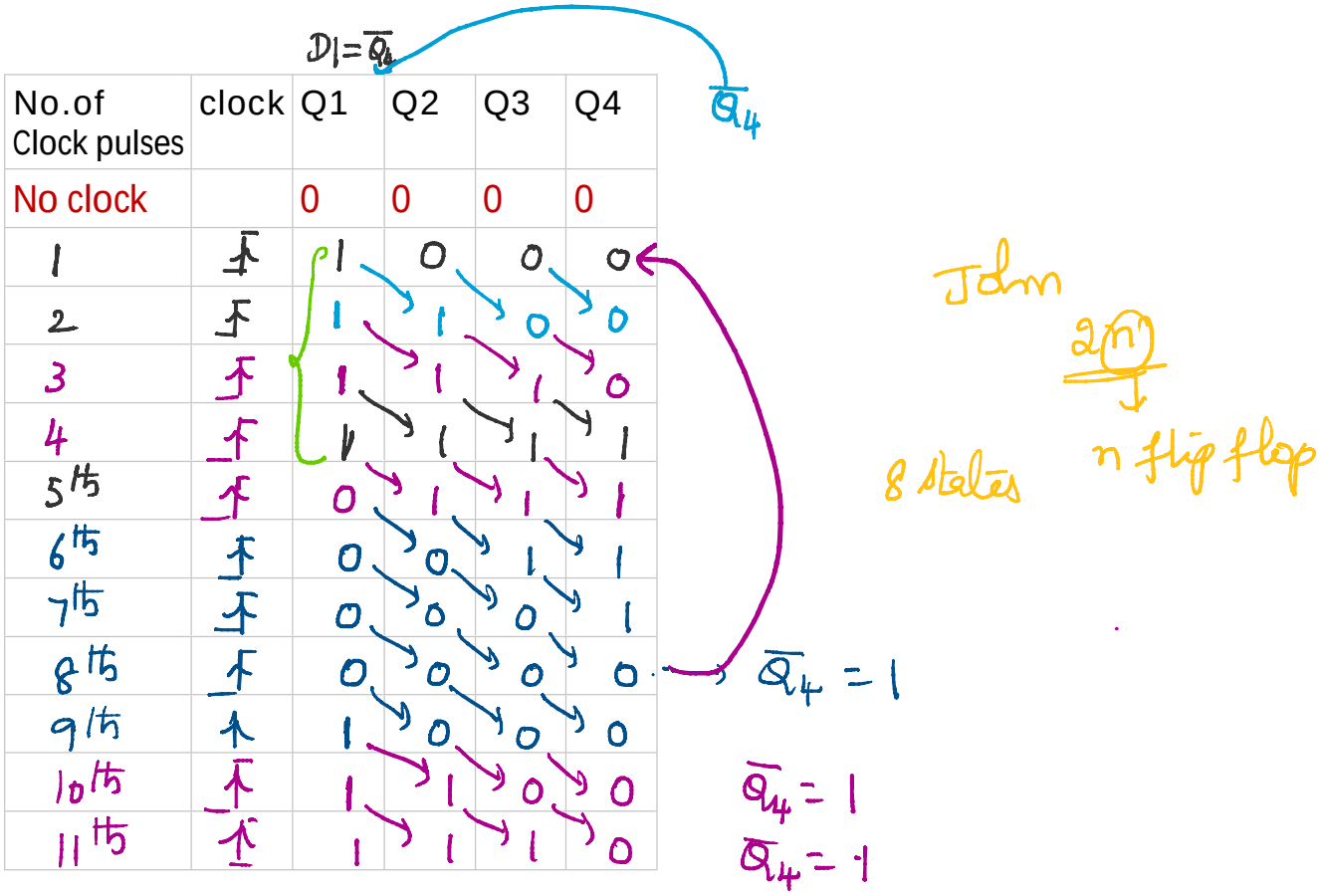
$\overline{Q_4}$ → 0

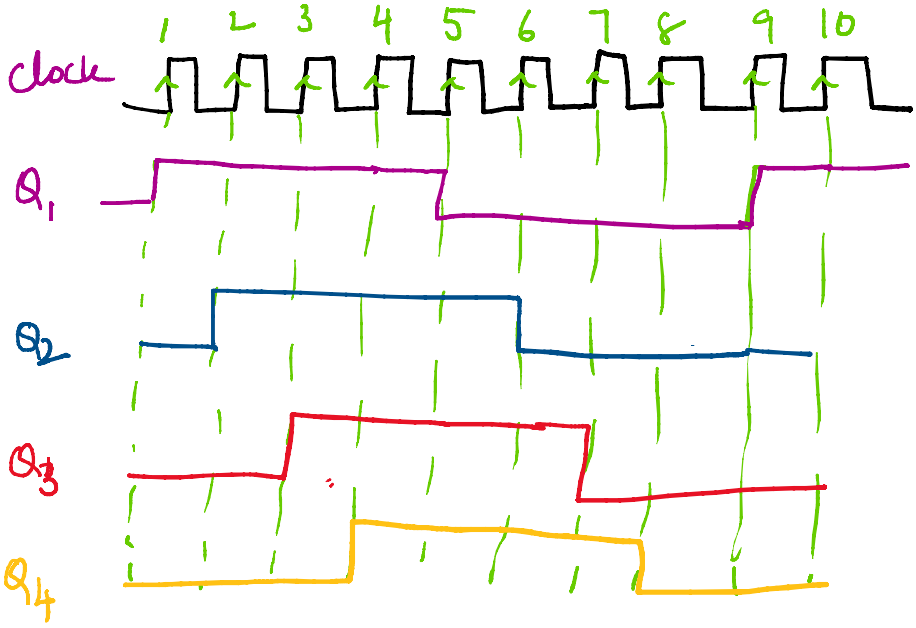
Eighth Clock pulse



clock	D1 = $\overline{Q4}$	Q1	Q2	Q3	Q4
7 th	0	0	0	0	1
8 th	1	0	0	0	0

$\overline{Q_4}$ → 1

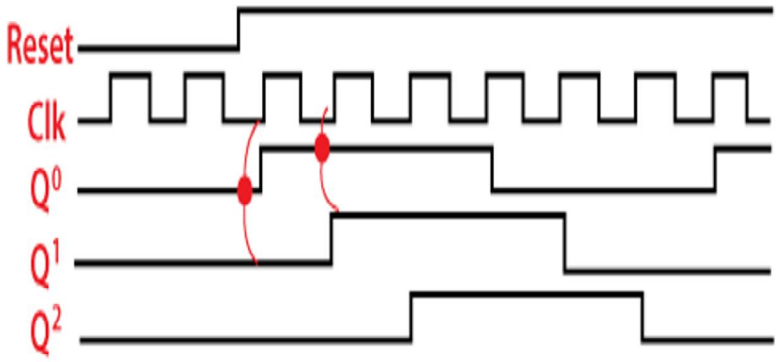

$D_1 = \overline{Q_4}$
$\overline{Q_4}$
No.of Clock pulses
clock
Q1
Q2
Q3
Q4
No clock
0 0 0 0
1
2
3
4
5th
6th
7th
8th
9th
10th
11th
1 0 0 0
1 1 0 0
1 1 1 0
1 1 1 1
0 1 1 1
0 0 1 1
0 0 0 1
0 0 0 0
1 0 0 0
1 1 0 0
1 1 1 0
$\overline{Q_4} = 1$
$\overline{Q_4} = 1$
$\overline{Q_4} = 1$
John
2(n)
n flip flop
8 states



The above table state that

- The counter produces the output 0000 when there is no clock input passed(0).
- The counter produces the output 1000 when the 1st clock pulse is passed to the flip flops.
- The counter produces the output 1100 when the 2nd clock pulse is passed to the flip flops.
- The counter produces the output 1110 when the 3rd clock pulse is passed to the flip flops.
- The counter produces the output 1111 when the 4th clock pulse is passed to the flip flops.
- The counter produces the output 0111 when the 5th clock pulse is passed to the flip flops.
- The counter produces the output 0011 when the 6th clock pulse is passed to the flip flops.
- The counter produces the output 0001 when the 7th clock pulse is passed to the flip flops.

Timing diagram



Advantages

- The number of flip flops in the Johnson counter is equal to the number of flip flops in the ring counter, and the Johnson counter counts twice the number of states the ring counter can count.
- The Johnson counter can also be designed by using D or JK flip flop.
- The data is count in a continuous loop in the Johnson ring counter.
- The circuit of the Johnson counter is self-decoding.

Disadvantages

- The Johnson counter is not able to count the states in a binary sequence.
- In the Johnson counter, the unutilized states are greater than the states being utilized.
- The number of flip flops is equal to one half of the number of timing signals.
- It is possible to design the Johnson counter for any number of timing sequences.