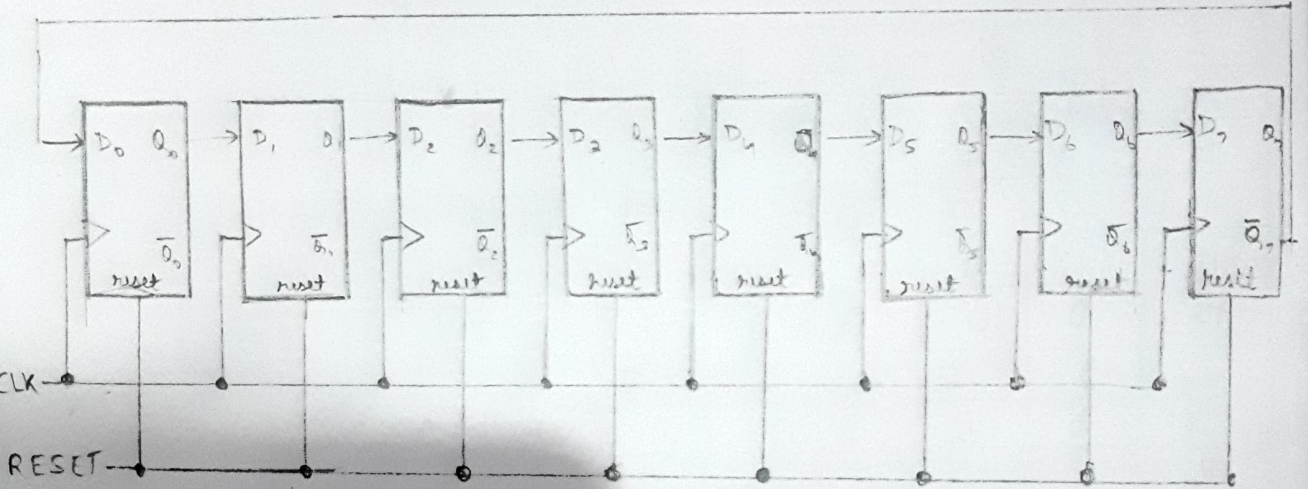


JOHNSON COUNTER

Johnson Counter is commonly used in digital circuits to store / count / process the number of events that occur in a circuit. It is also known as creeping counter or modified ring counter. Ring counters are often used in FPGA or ASIC design to construct FSM (Finite state Machines). In the Johnson counter, the complement of the last flip-flop's output is connected as input to the first flip-flop.



2-bit Johnson Counter

Johnson Counters are used extensively as frequency dividers. They can also be used to recognize patterns. It is also used as a synchronous decade counter.

Truth Table

CLK	Q_0	Q_1	Q_2	Q_3	Q_4	Q_5	Q_6	Q_7
0	0	0	0	0	0	0	0	0
1	1	0	0	0	0	0	0	0
2	1	1	0	0	0	0	0	0
3	1	1	1	0	0	0	0	0
4	1	1	1	1	0	0	0	0
5	1	1	1	1	1	0	0	0
6	1	1	1	1	1	1	0	0
7	1	1	1	1	1	1	1	0
8	1	1	1	1	1	1	1	1
9	0	1	1	1	1	1	1	1
10	0	0	1	1	1	1	1	1
11	0	0	0	1	1	1	1	1
12	0	0	0	0	1	1	1	1
13	0	0	0	0	0	1	1	1
14	0	0	0	0	0	0	1	1
15	0	0	0	0	0	0	0	1
16	0	0	0	0	0	0	0	0

Working

- 1) So initially, the clock state is 0 and all the Q 's are zero.
- 2) The output becomes 10000000 at the 1st clock positive edge.
- 3) The output becomes 11000000 at the next clock positive edge as Q_1 becomes 1.
- 4) The output becomes 11100000 at next clock positive edge as Q_2 becomes 1.
- 5) Similarly, after a few more clock positive edges, the output becomes 11111111.
- 6) At the next clock positive edge, the output is 01111111 since $\overline{Q_7}$ is connected as input to the 1st D flip-flop.
- 7) At next clock positive edge, output becomes 00111111.
- 8) Similarly the process continues and once again we reach the initial state 00000000 and then the cycle has started again.

Advantages of using the Johnson Counter

1. Using a ring counter of n flip flops we can count only n states but using the Johnson counter, we can count $2n$ states.
2. It can be implemented using only D flip-flops or JK flip flops.
3. The delay in any ring counter is constant regardless of the no of bits. This is not the case in binary counters

Disadvantages of Johnson Counter

1. There are 2^n possible states using n flip-flops but Johnson counter can represent only $2n$ states.
2. ~~Johnson~~ Johnson counter doesn't count in a binary sequence.