



Digital Design : 2021-22

Lecture 24 : Asynchronous Counters

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Counters

- A counter is basically a register that goes through a prescribed sequence of states upon the application of input pulses
 - input pulses are usually clock pulses
- Example: n-bit binary counter
 - count in binary from 0 to $2^n - 1$
- Classification
 1. Ripple counters
 - flip-flop output transition serves as *the* pulse to trigger other flip-flops
 2. Synchronous counters
 - flip-flops receive the same common clock as *the* pulse

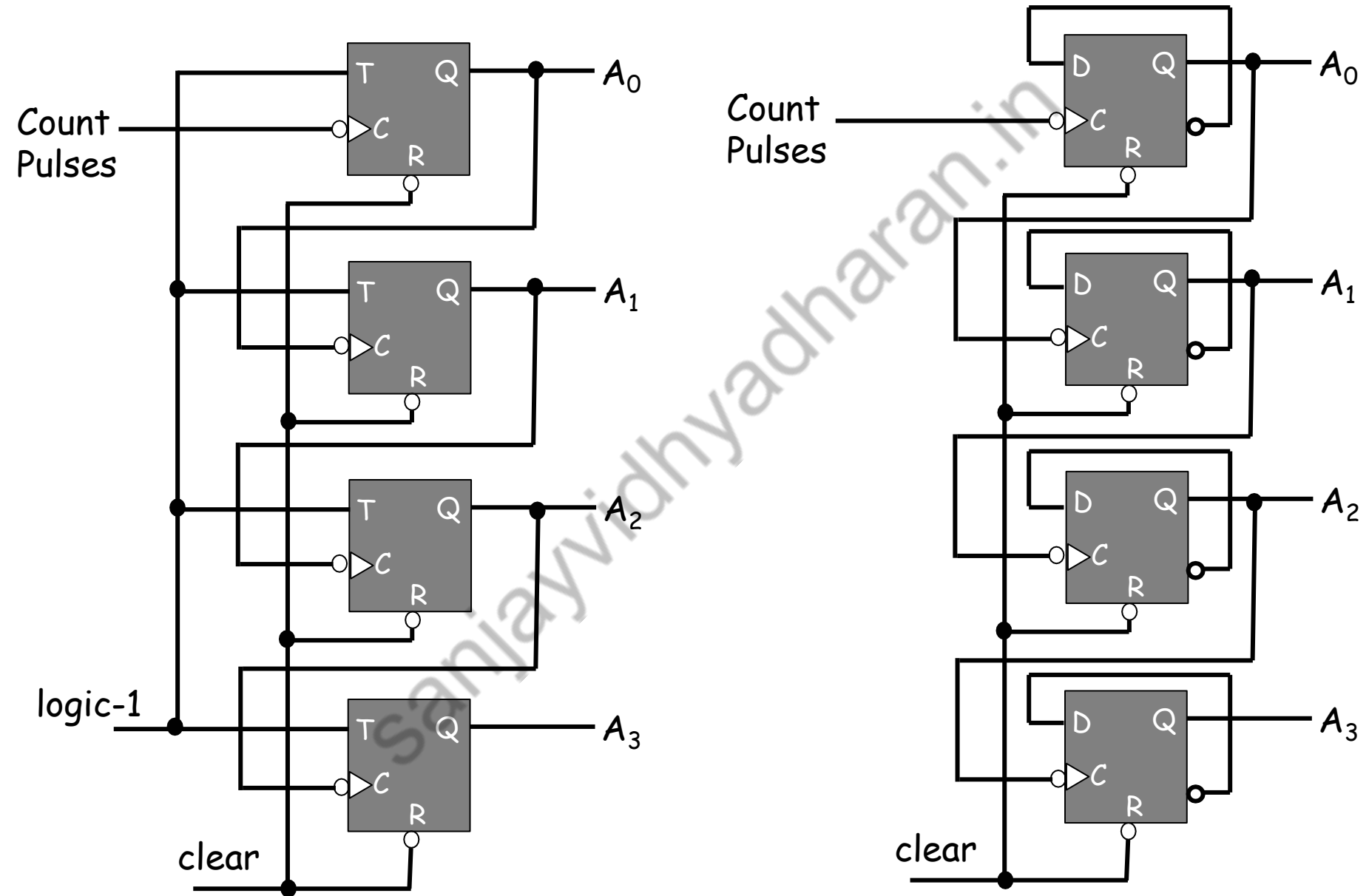
Binary Ripple Counter

3 bit binary ripple counter

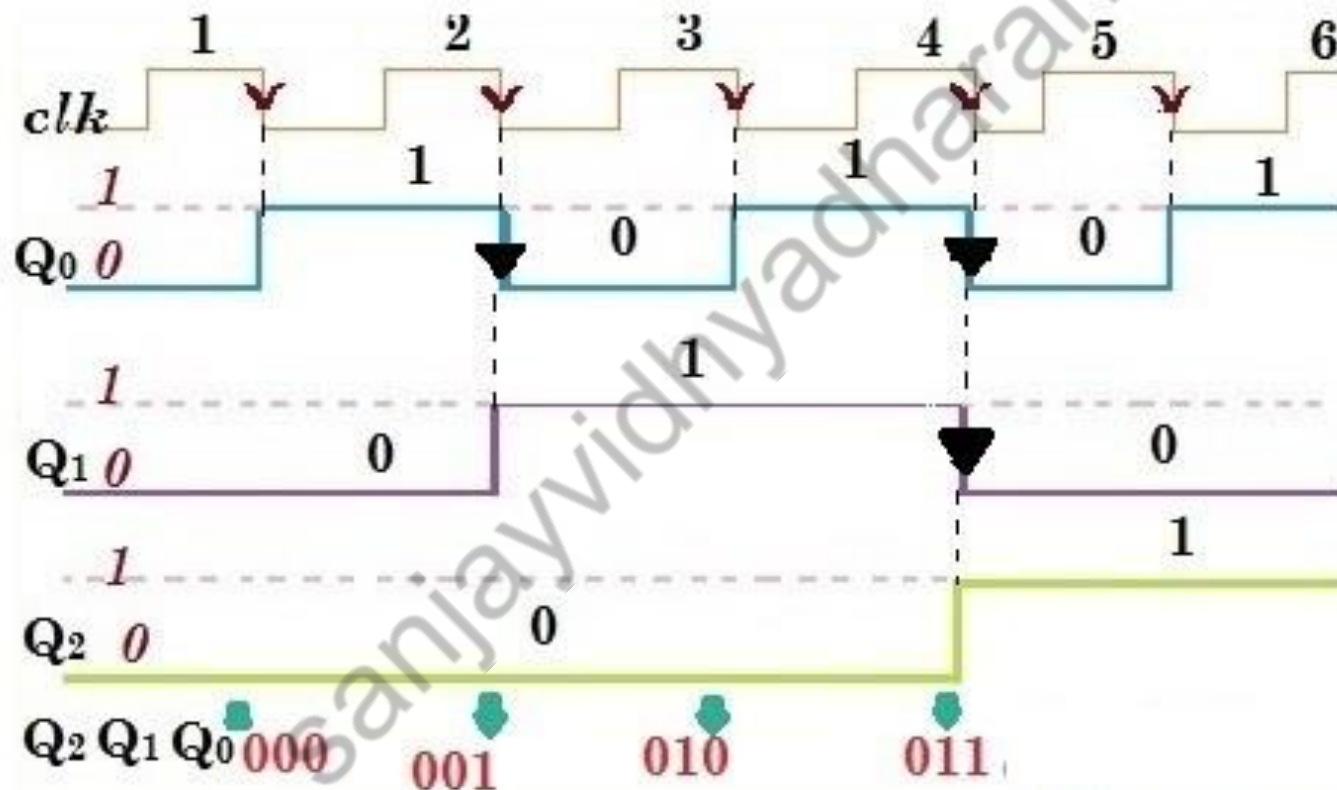
0	0	0	0
1	0	0	1
2	0	1	0
3	0	1	1
4	1	0	0
5	1	0	1
6	1	1	0
7	1	1	1
0	0	0	0

- Idea:
 - to connect the output of one flip-flop to the C input of the next high-order flip-flop
- We need “complementing” flip-flops
 - We can use T flip-flops to obtain complementing flip-flops or
 - JK flip-flops with its inputs are tied together or
 - D flip-flops with complement output connected to the D input.

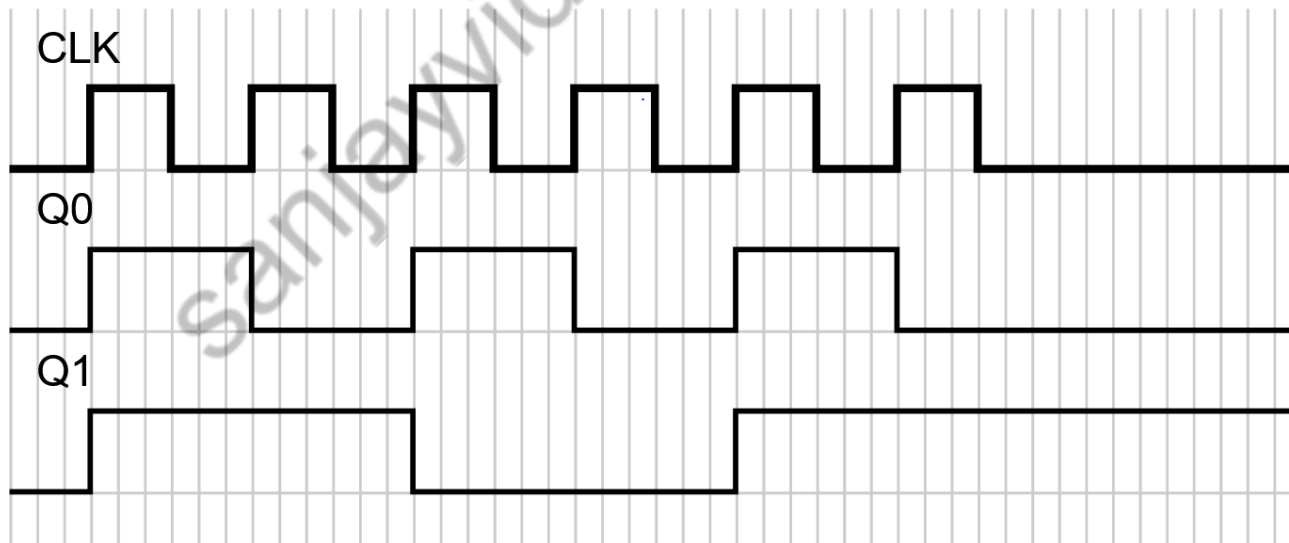
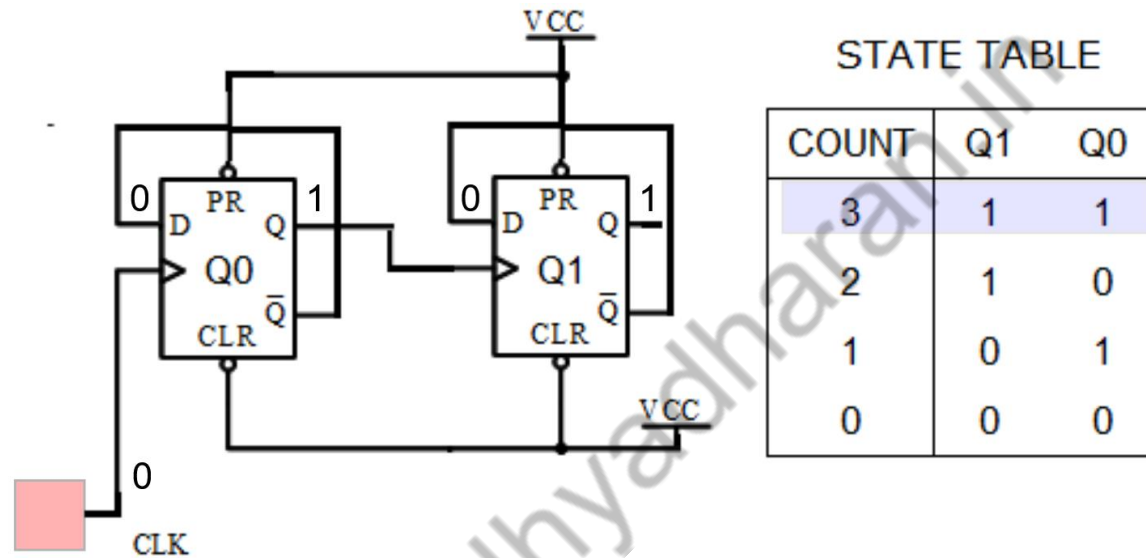
4-bit Binary Ripple Up-Counter



Binary Ripple Up-Counter

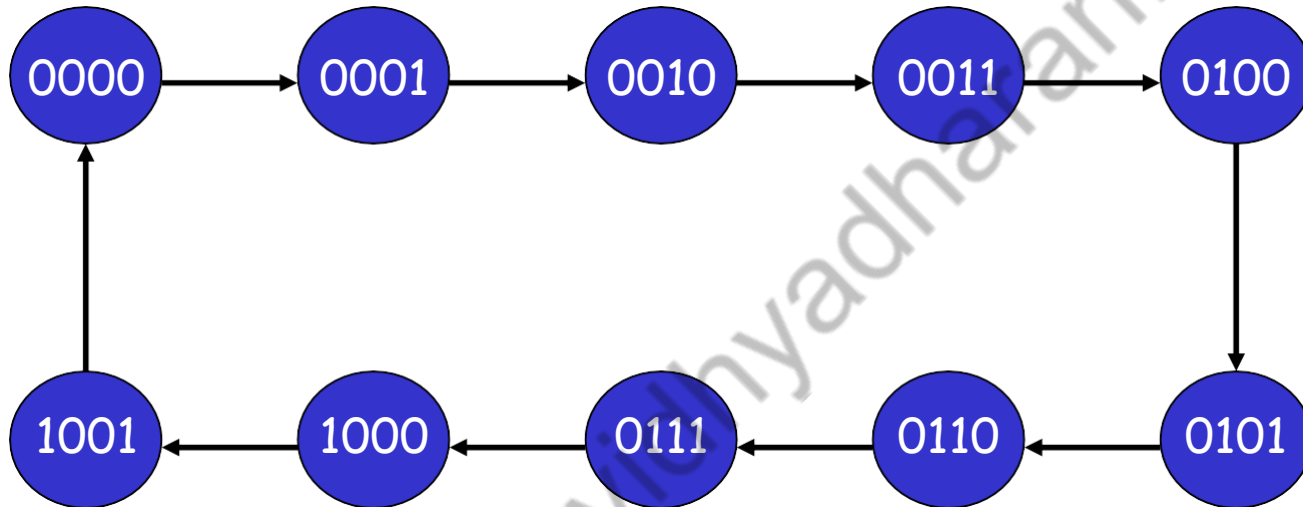


4-bit Binary Ripple Down-Counter



BCD Ripple Counter

- State diagram

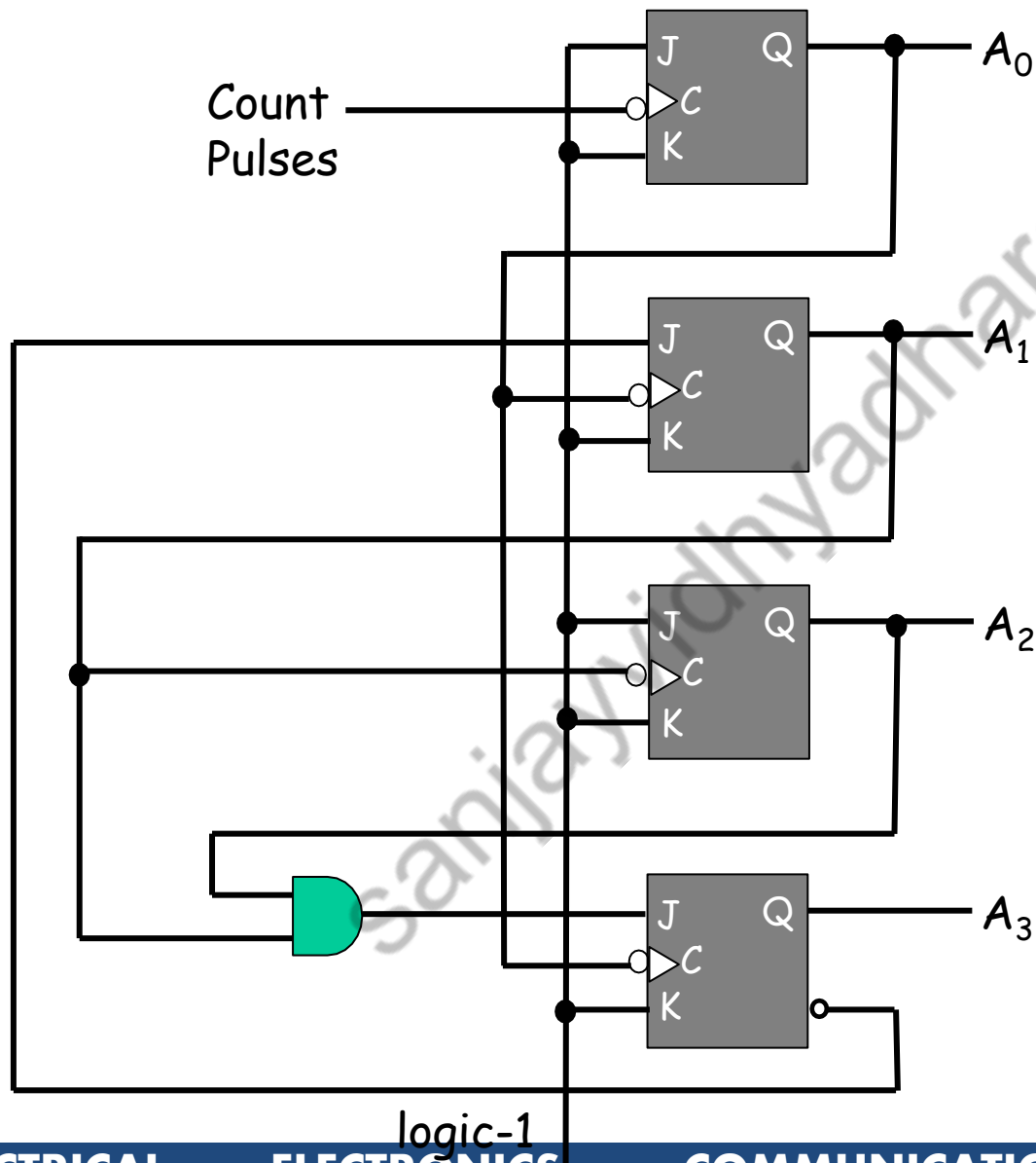


BCD Ripple Counter

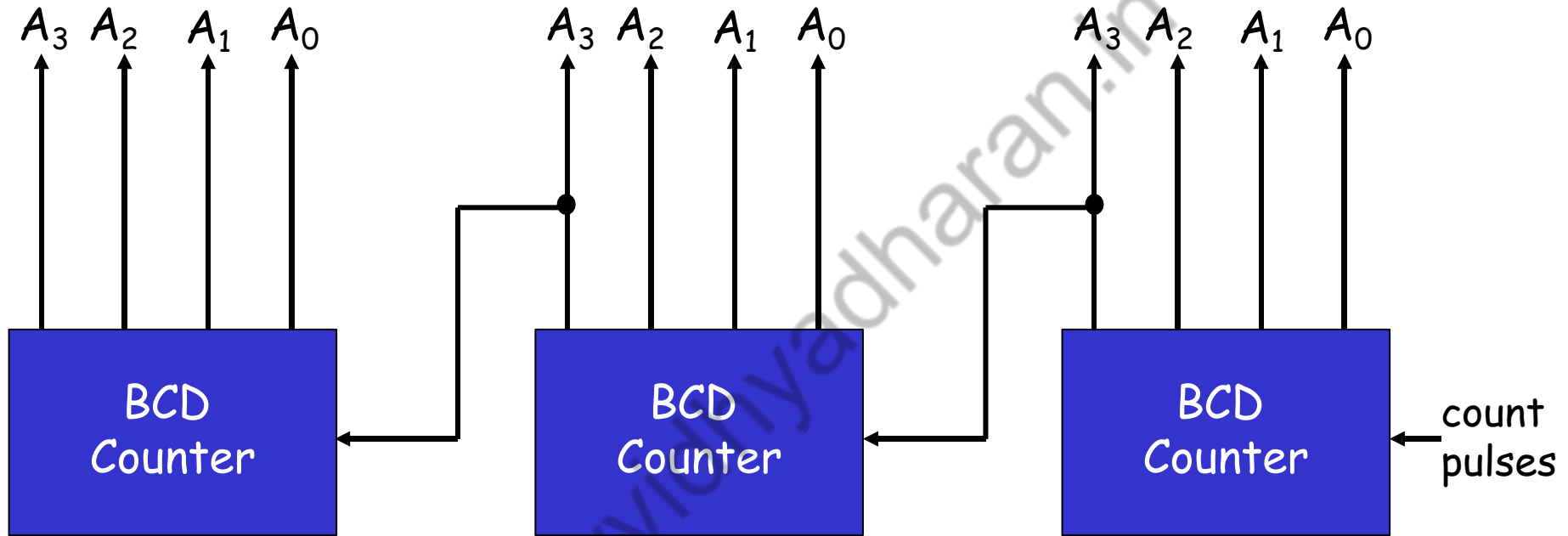
- State transitions

A_3	A_2	A_1	A_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

BCD Ripple Counter with JK FFs



Multi-digit BCD Counter



3-digit BCD counter

Thank you