Digital Electronics and Computer Organization

Digital Design

Lecture 22: Asynchronous Counters

Birla Institute of Technology & Science, Pilani
Hyderabad Campus

Innovate achieve lead

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

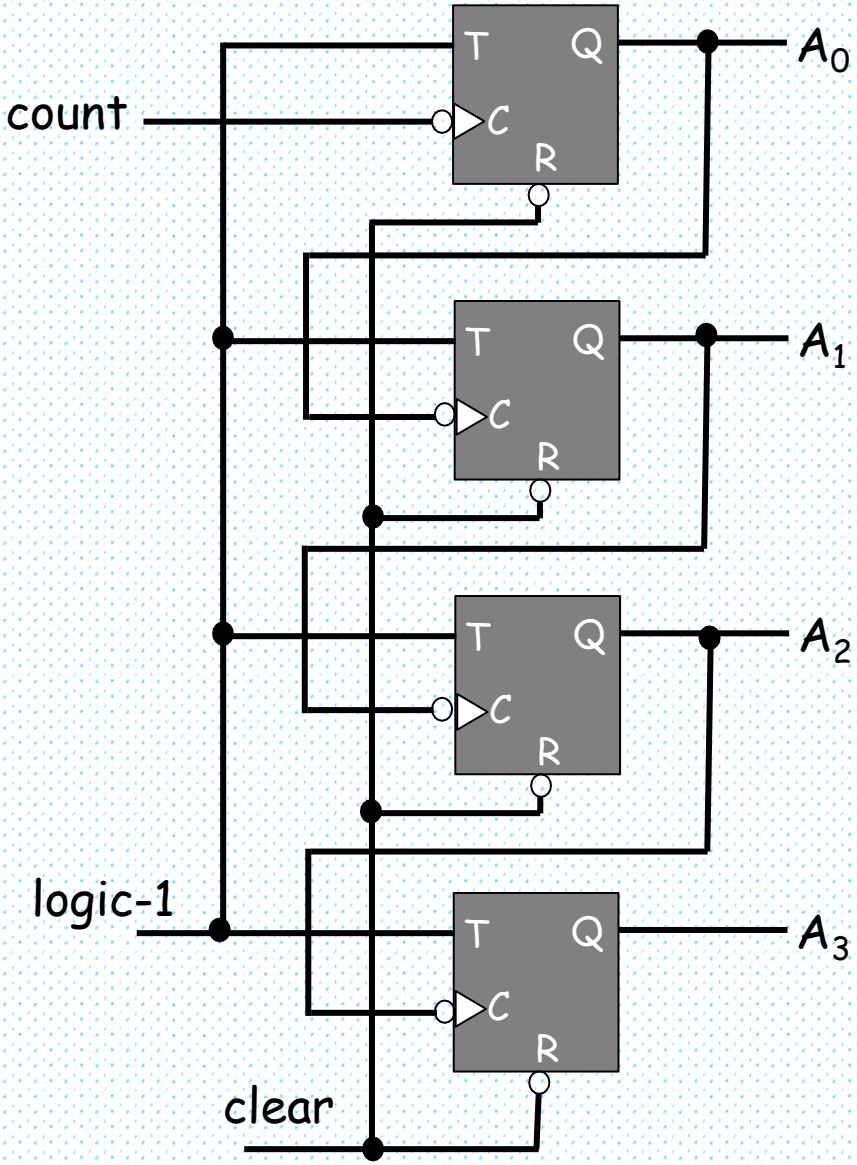
Binary Ripple Counter

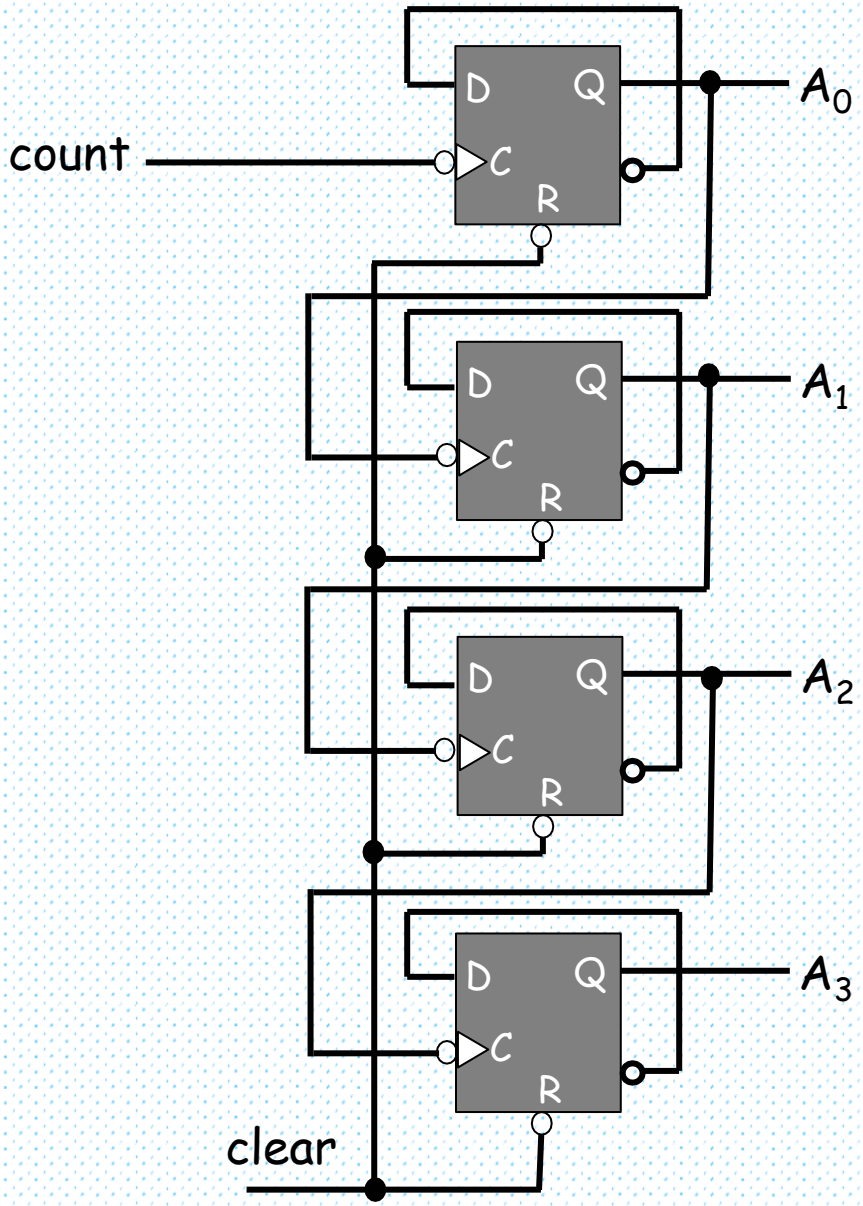
3 bit binary ripple counter

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

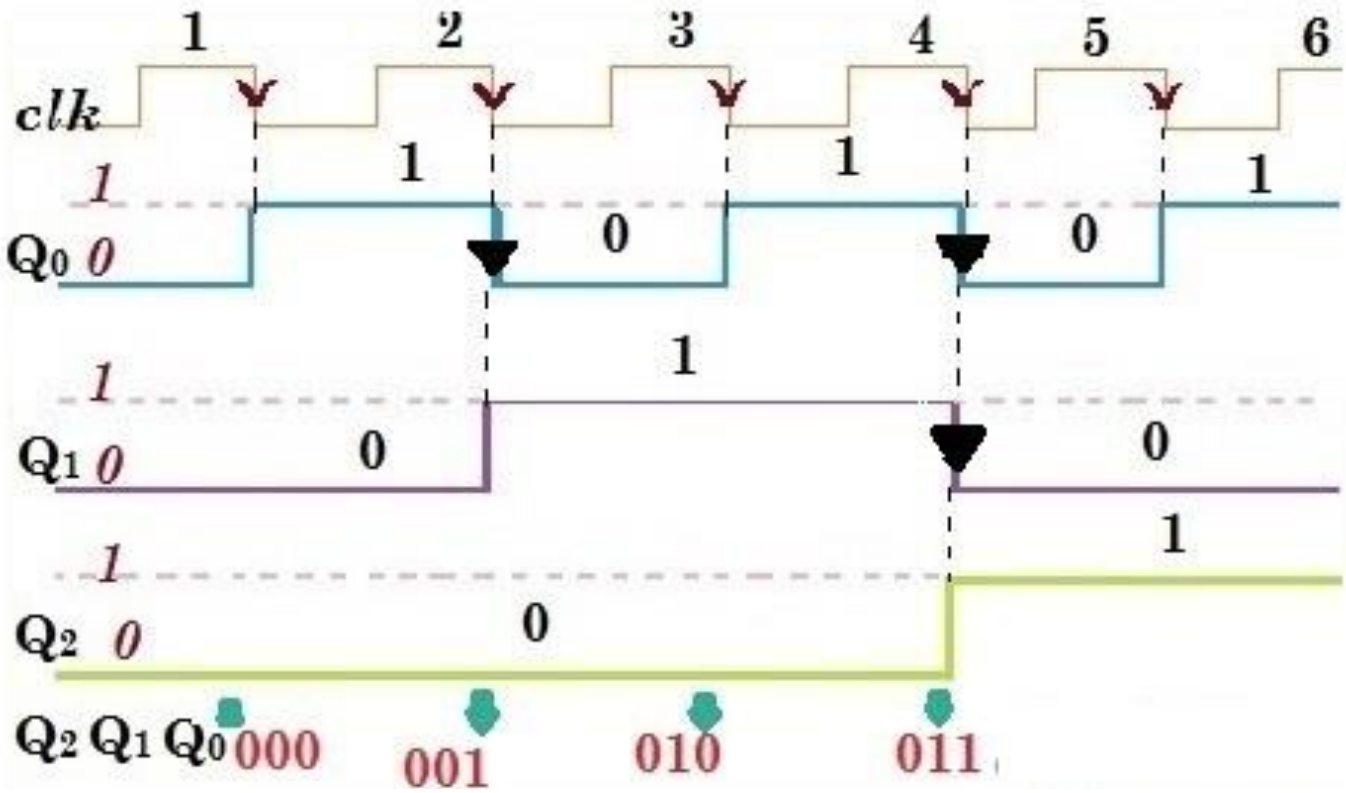
- Idea:
  - to connect the output of one flip-flop to the C input of the next high-order flip-flop
- We need "complementing" flip-flops
  - We can use T flip-flops to obtain complementing flip-flops or
  - JK flip-flops with its inputs are tied together or
  - D flip-flops with complement output connected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

4-bit Binary Ripple Up-Counter

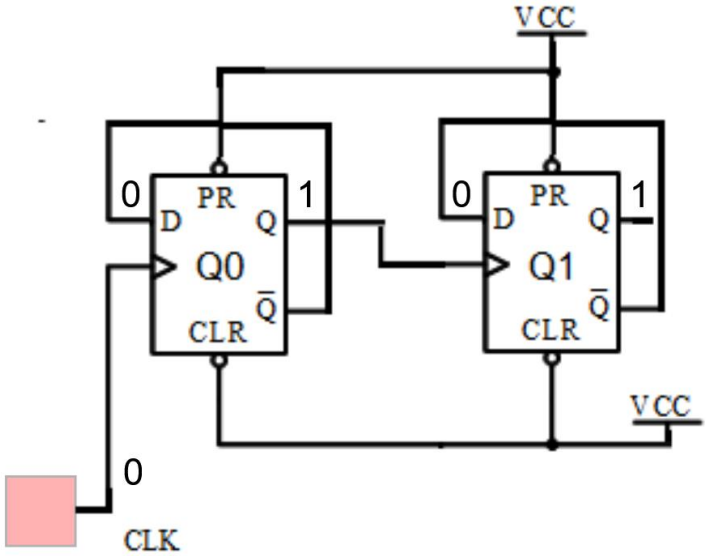




Binary Ripple Up-Counter

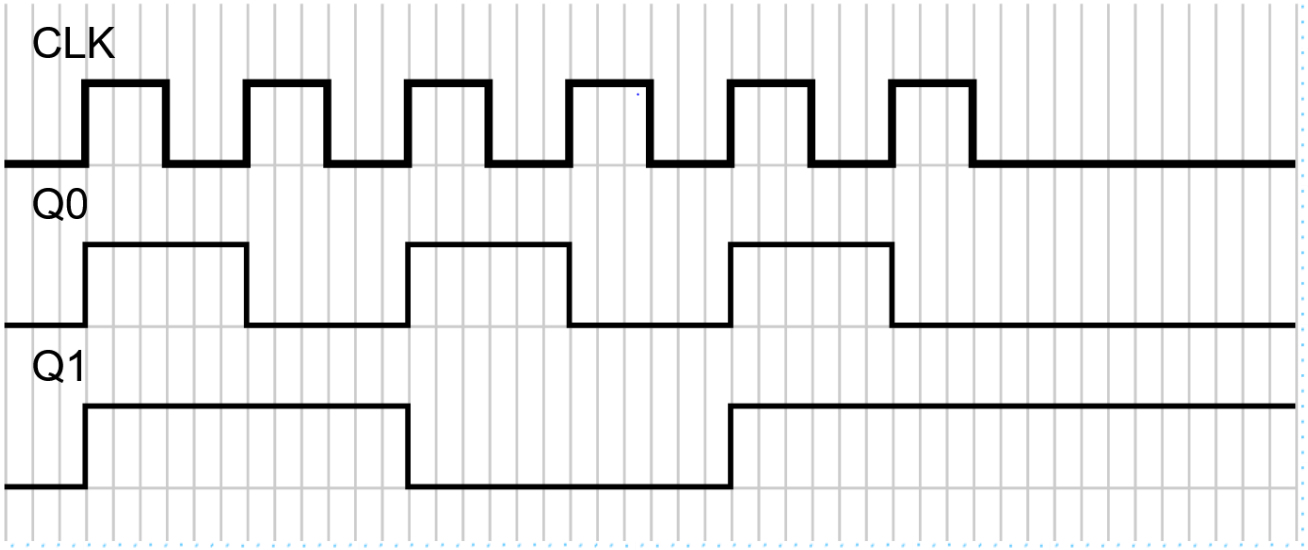


4-bit Binary Ripple Down-Counter



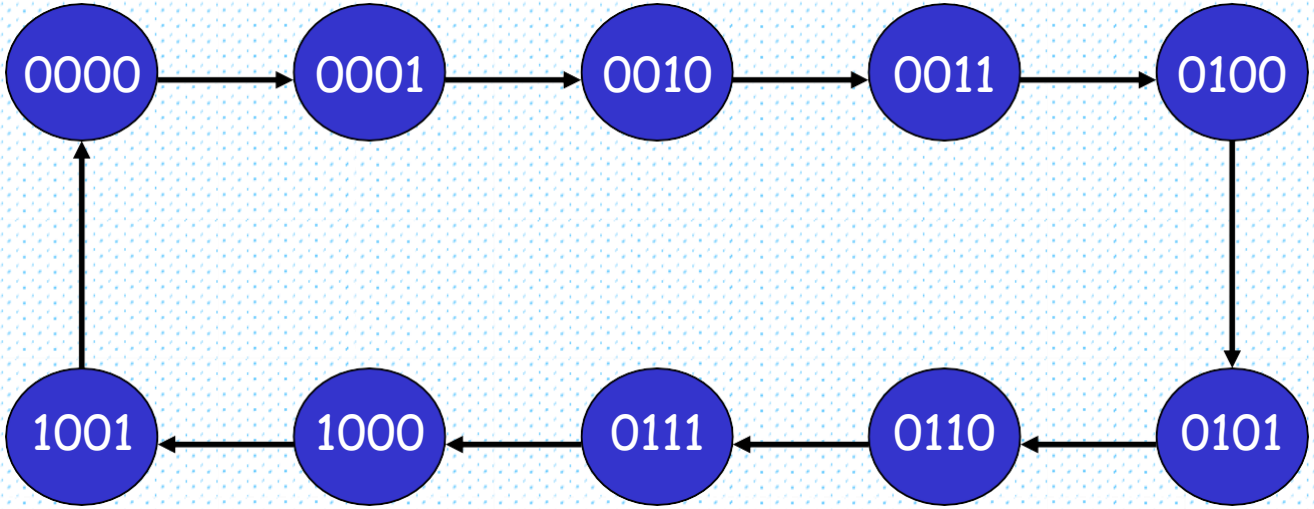
STATE TABLE

COUNT	Q1	Q0
3	1	1
2	1	0
1	0	1
0	0	0



BCD Ripple Counter

- State diagram

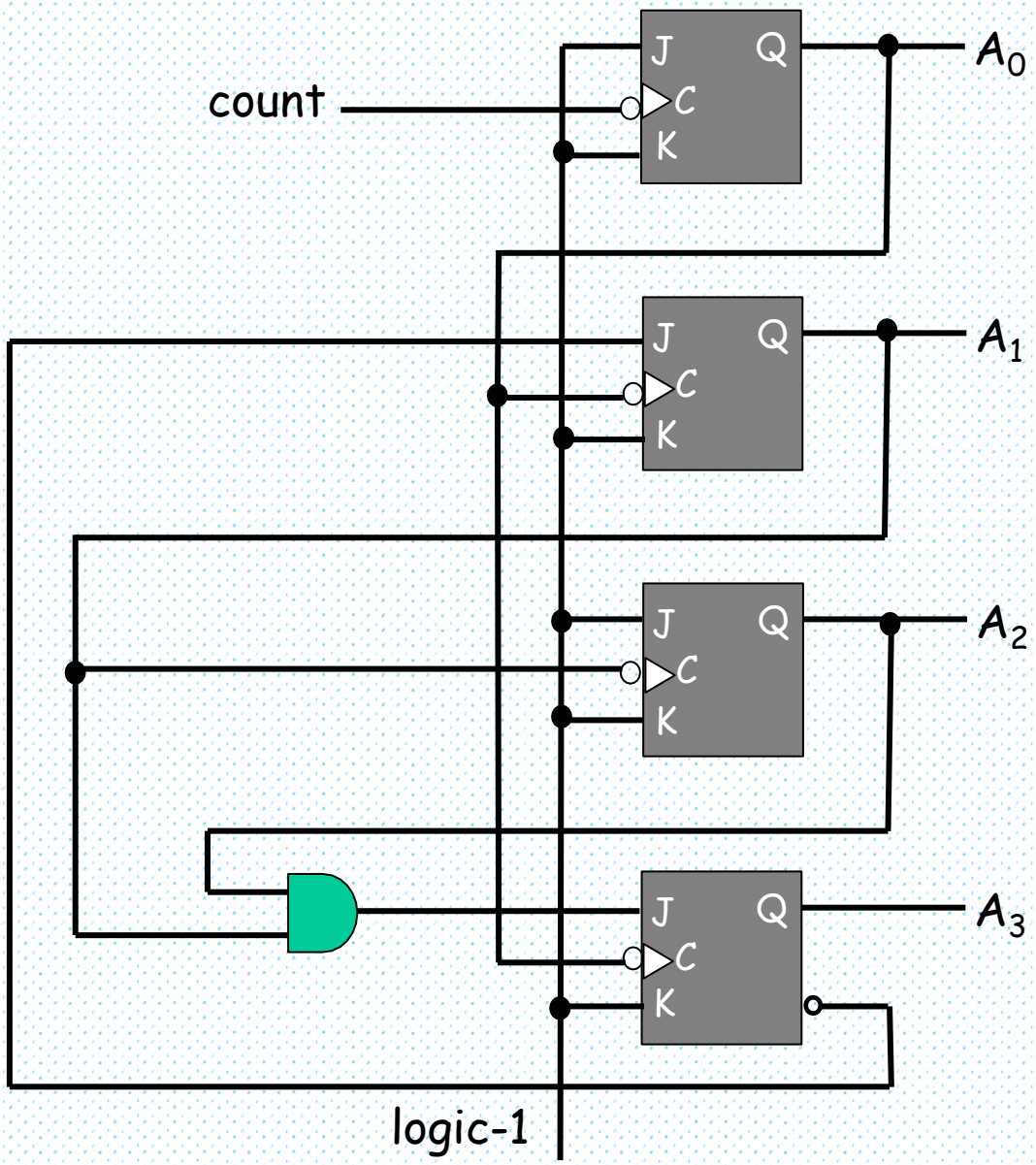


BCD Ripple Counter

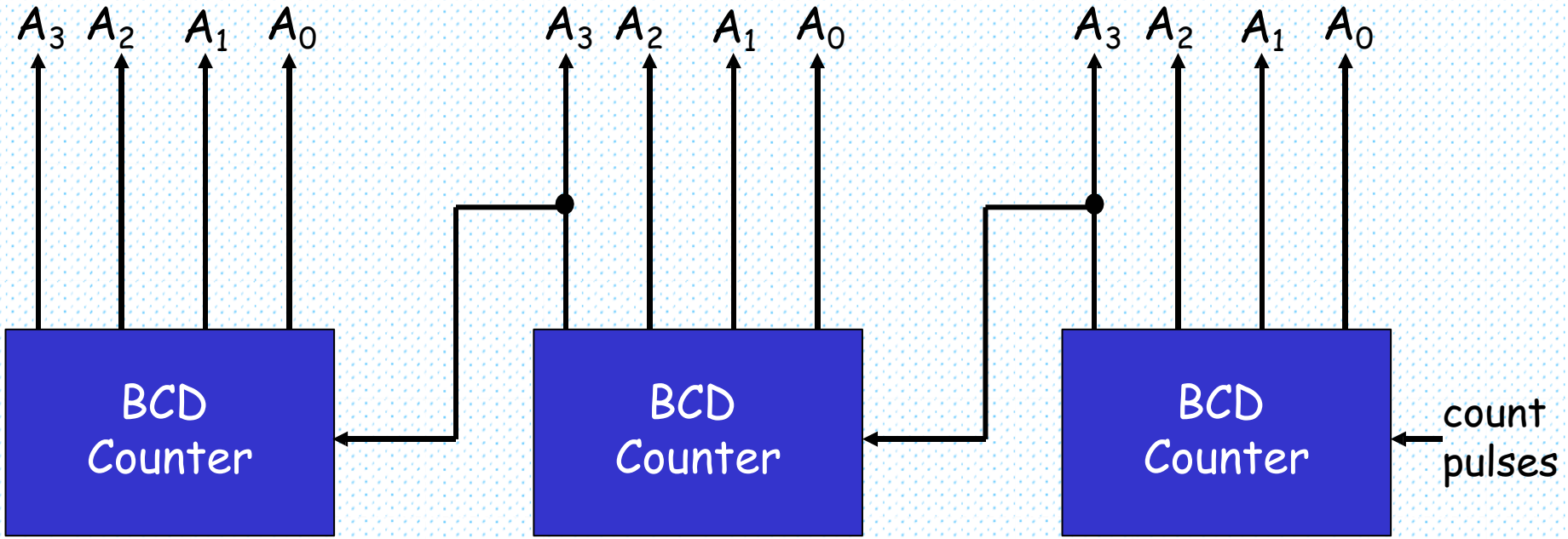
- State transitions

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

Thankyou