

Lecture 22: Asynchronous Counters

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 2ⁿ-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
	0	0	1
2	0	1	0
3	0	1	<u></u> [
4	1	0	0
5	<u> </u>	0	
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



BCD Ripple Counter with JK FFs



Multi-digit BCD Counter



3-digit BCD counter

