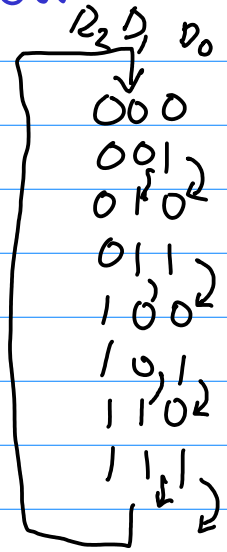
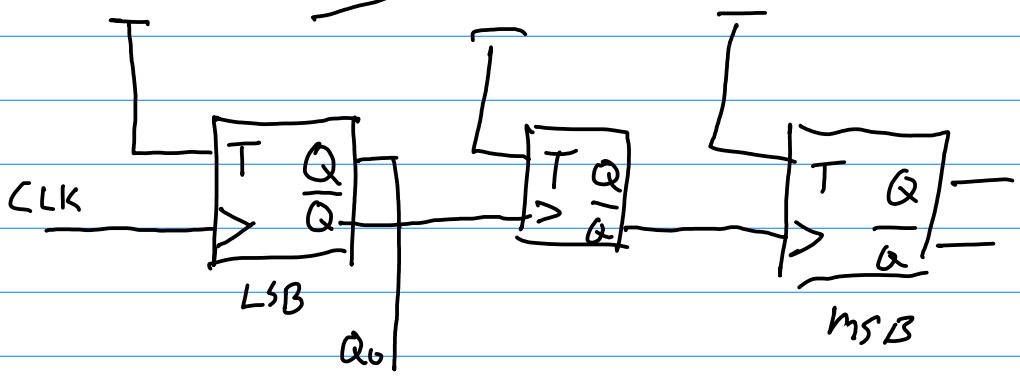
Counters:

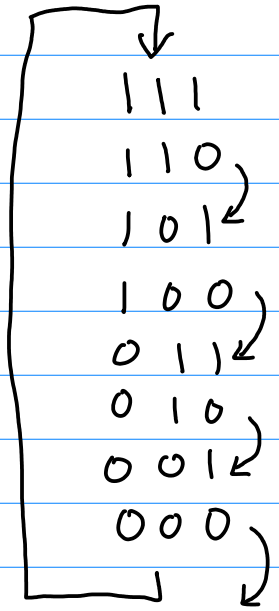


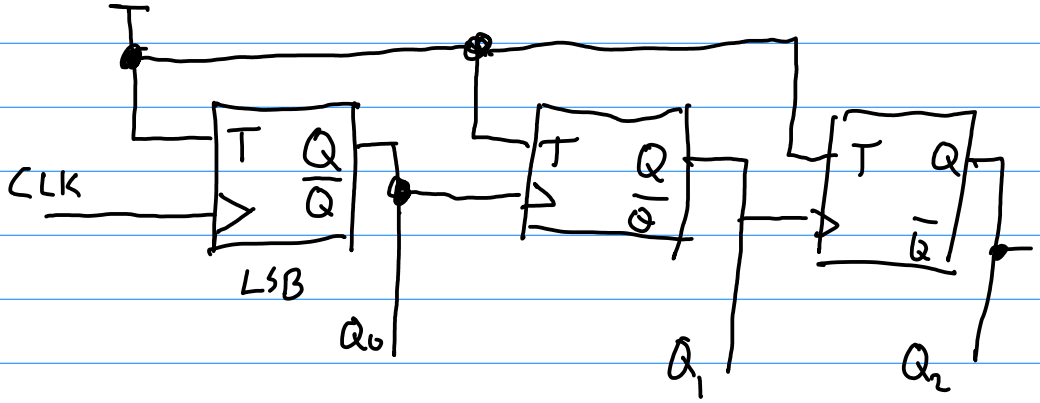
Asynchronous



Note Ripple!

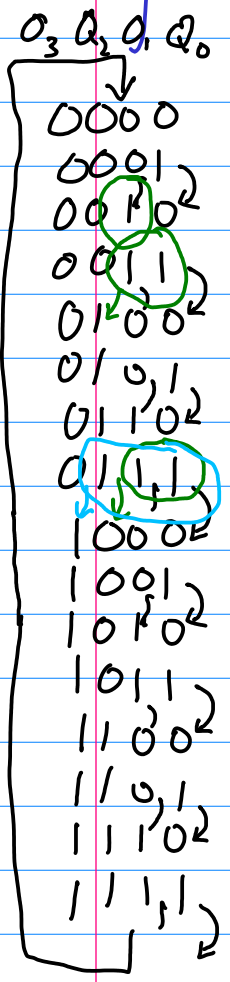
Count Down

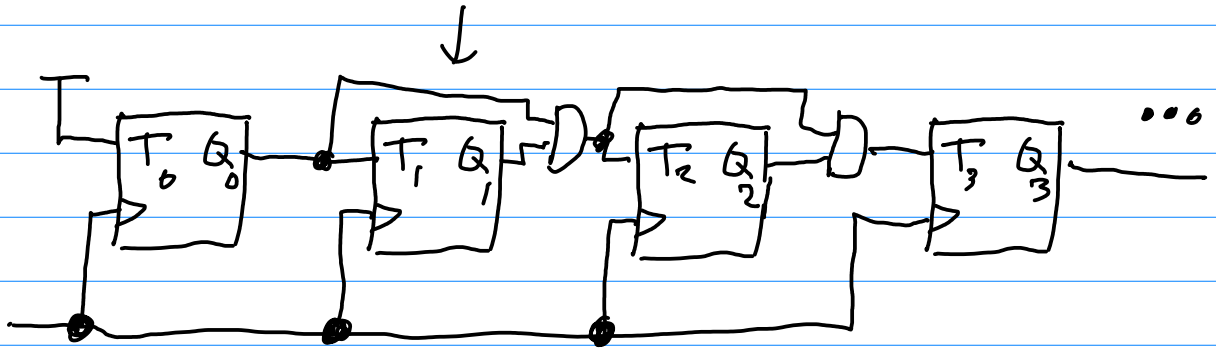




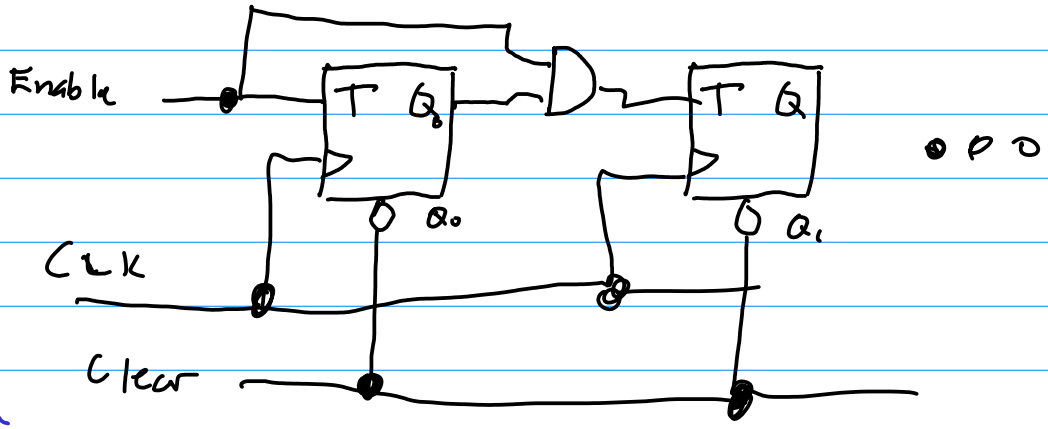
Asynchronous: Bits don't all change at the same time

Synchronous — same clock goes to all flip-flops

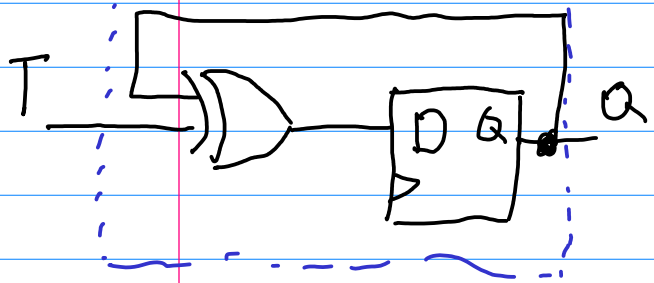


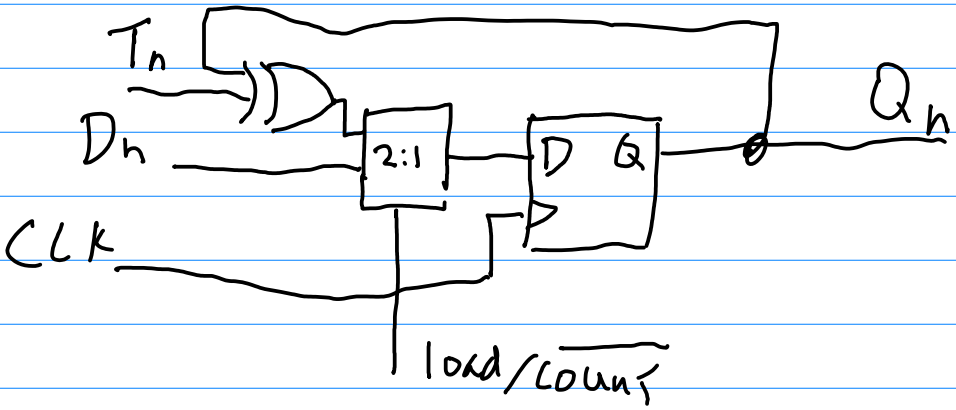


Enable & clear



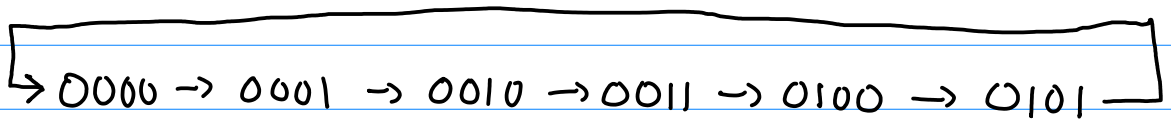
T-ff



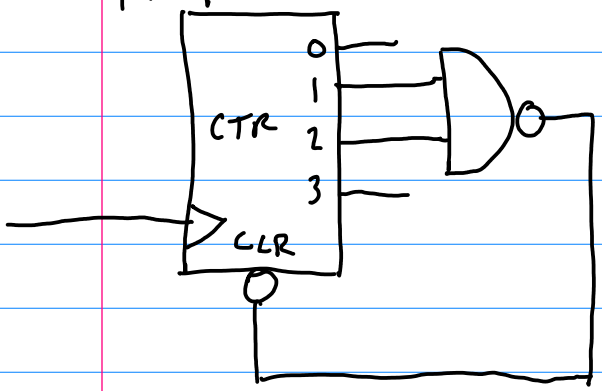


Modulo - n counter

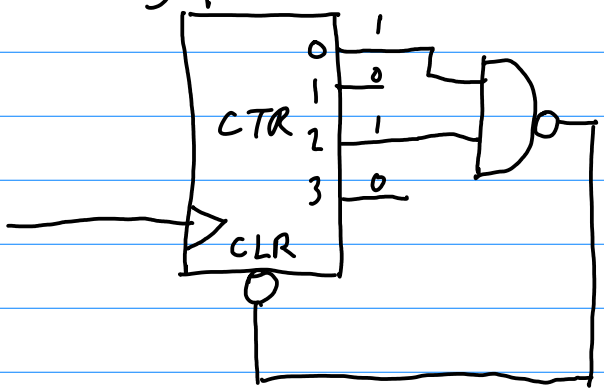
Note BCD counter would go to 9 and then reset

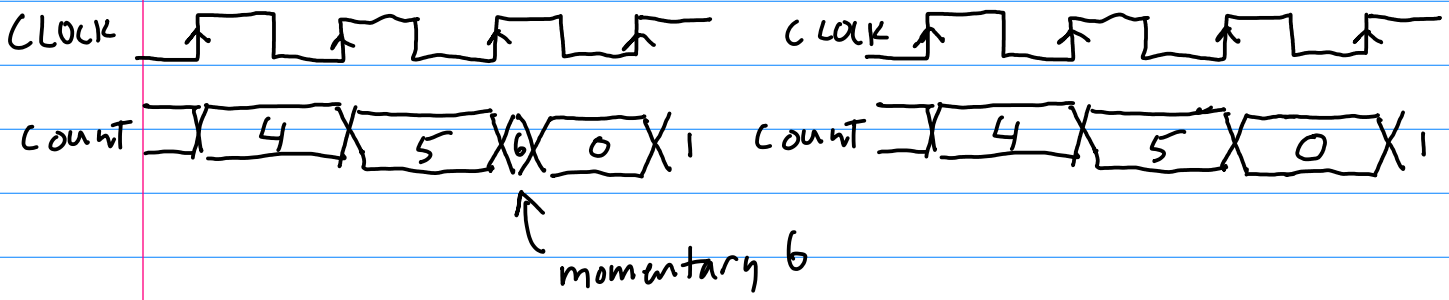


Asynchronous

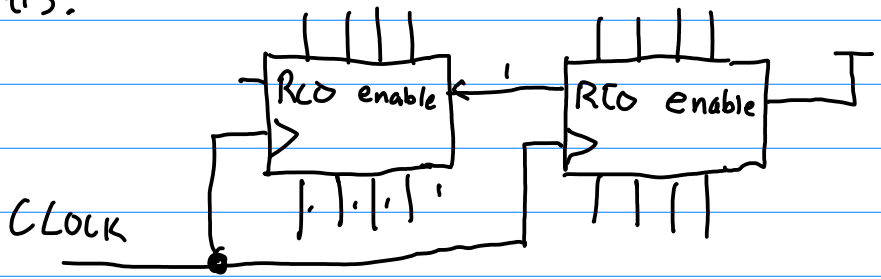


Synchronous





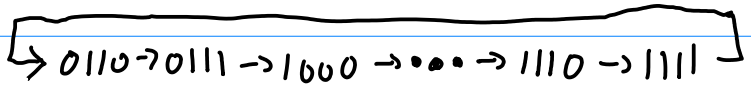
Cascade Counters:

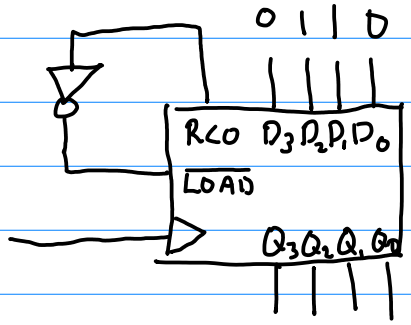


RCO = 1 when count = 1111 AND $RCO_{IN} = 1$

e.g.

Count 6 → 15

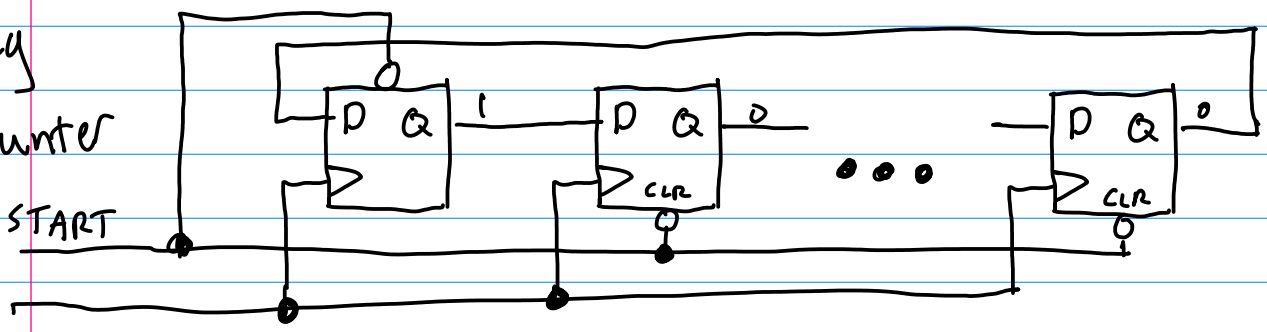




Another Shift register

"One-hot" encoding

Ring Counter



START will preload → 10000000

01000000

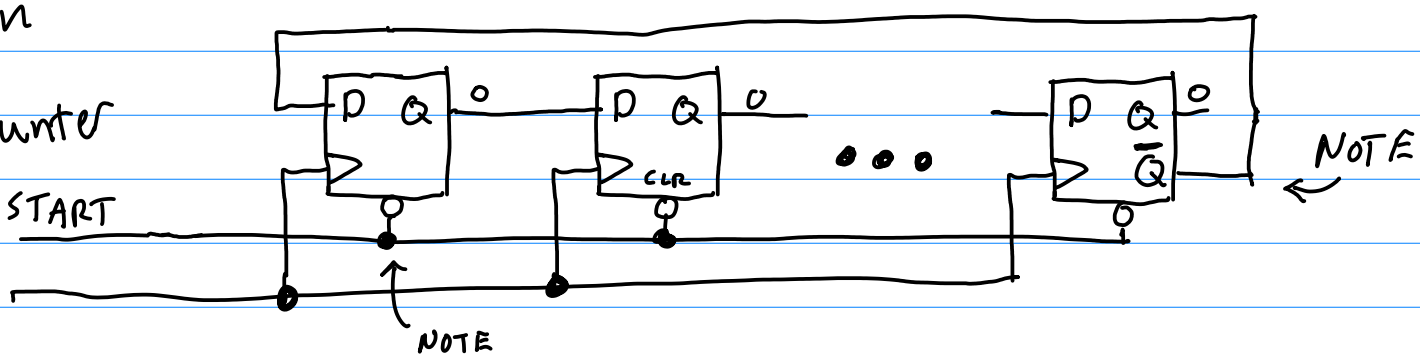
00100000

etc

00000001

One-hot

Johnson Counter



Count →

0000

1000

1100

1110

1111

0111

0011

0001

NOTE

can use JK-ff for shift registers