State diagram of counter

State diagram of a counter represent the state of a counter graphically.

e.g. State diagram of a 2-bit up counter is shown below,

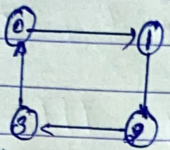
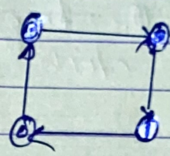


Fig: State diagram of 2-bit up counter



Fig(b): 2 bit down counter

Fig: State diagram of 2 bit up/down counter.

Asynchronous down counters: The counter which count in downward direction i.e from the maximum count to zero are called down counters.

The below figure shows the circuit diagram of a 3-bit down counter

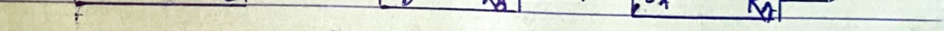


Fig: A - 3 bit Asynchronous down counter.

In down counter each FF except the first one A toggle when the preceding FF output changes from LOW to HIGH.

Working operation:

Let initially all the flip-flops be in the reset condition

Therefore, $Q_C Q_B Q_A = 000$.

As soon as the first falling clock pulse arrives, FF-A toggles, so, Q_A becomes 1 and $\bar{Q}_A$ becomes 0 from 1. Also, $\bar{Q}_A$ acts as a clock pulse to FF-B, that will change its state. So, $Q_B = 1$, $\bar{Q}_B = 0$. This $\bar{Q}_B$ acts as clock pulse to FF-C will change its state. Hence Q_C becomes 1 and $\bar{Q}_C = 0$. So, after the first clock pulse,

$$Q_C Q_B Q_A = 111$$

On second falling edge of clock pulse,

$$Q_C Q_B Q_A = 110.$$

On third falling edge,

$$Q_C Q_B Q_A = 101$$ and so on.

counting take place.

Timing diagram:

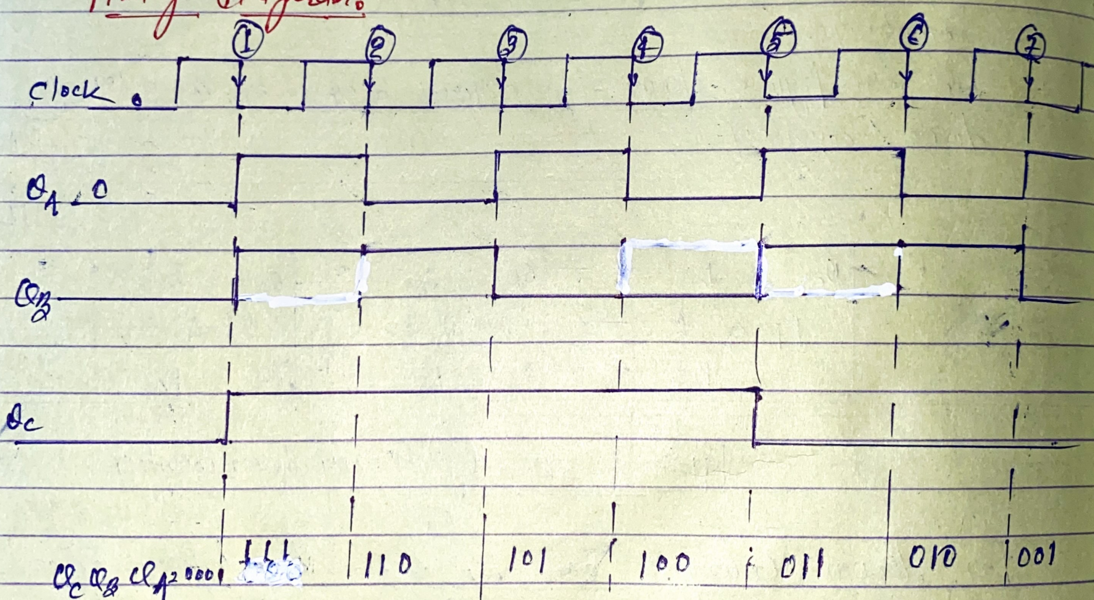


Fig: Timing diagram of a 3-bit down counter

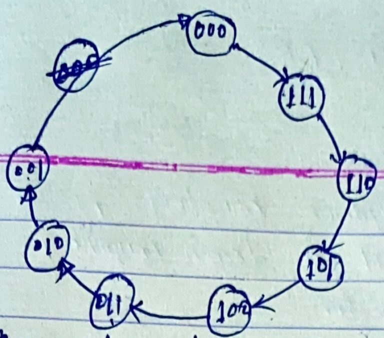


Fig: State diagram of a 3-bit ripple counter.

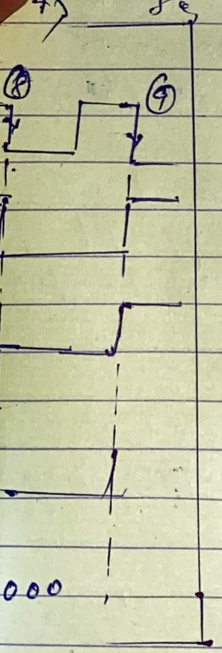
Drawbacks of Ripple counter:

1) Every flip-flop has its own propagation. As output of previous FF is used as clock for the next FF.

2) Hence, the propagation delay goes on accumulating. For a 3-bit ripple counter, the propagation delay of first FF gets added to that of second FF to decide the transmission time of the third stage.

3) So, with increasing no. of flip-flop propagation time increases.

4) So, There will be limitation on the maximum clock frequency.



5) The frequency f of a clock pulse for reliable accurate operation is given by

$$f \leq \frac{1}{n(t_d) + T_s}$$

where

n = No. of flip-flops

T_s = width of strobe pulse

t_d = propagation delay of one flipflop.