Ripple Counter- Asynchronous Counter

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Ripple Counter-Introduction

Ripple counter is an Asynchronous counter. It got its name because the clock pulse ripples through the circuit. An n-MOD ripple counter contains n number of flip-flops and the circuit can count up to 2^n values before it resets itself to the initial value.

These counters can count in different ways based on their circuitry.

UP COUNTER: Counts the values in ascending order.

DOWN COUNTER: Counts the values in descending order.

UP-DOWN COUNTER: A counter which can count values either in the forward direction or reverse direction is called an up-down counter or reversible counter.

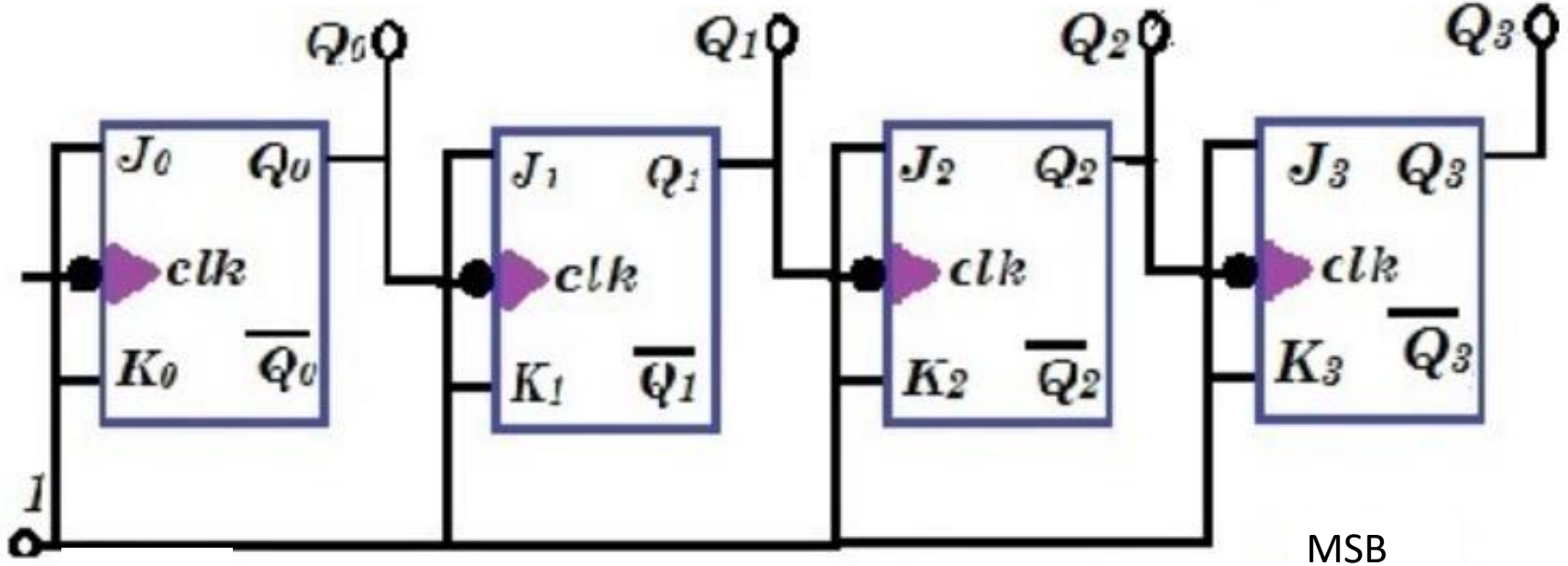
DIVIDE by N COUNTER: Instead of a binary, we may sometimes require to count up to N which is of base 10. Ripple counter which can count up to value N which is not a power of 2 is called Divide by N counter.

Ripple Counter using JK Flip Flop

The circuit arrangement of a **binary ripple counter** is as shown in the figure below. Here 4 **JK flip flops** are used. JK inputs of flip flops are supplied with high voltage signal maintaining them at a state 1. The symbol for the clock pulse indicates a negative triggered clock pulse. From the figure, it can be observed that the output Q0 of the first flip flop is applied as a clock pulse to the second flip flop.

So, according to the Truth table, when both the inputs are 1 the next state will be the complement of the previous state. This condition is used in ripple flip flop. As we have applied a high voltage to all the JK inputs of flip-flops they are at the state 1, so they must toggle the state at the negative going end of the clock pulse .i.e. at the transition 1 to 0 of the clock pulse. The timing diagram of the ripple counter clearly explains the operation.

4-bit Ripple Counter Using JK Flip flop – Circuit Diagram



Ripple Counter-Working

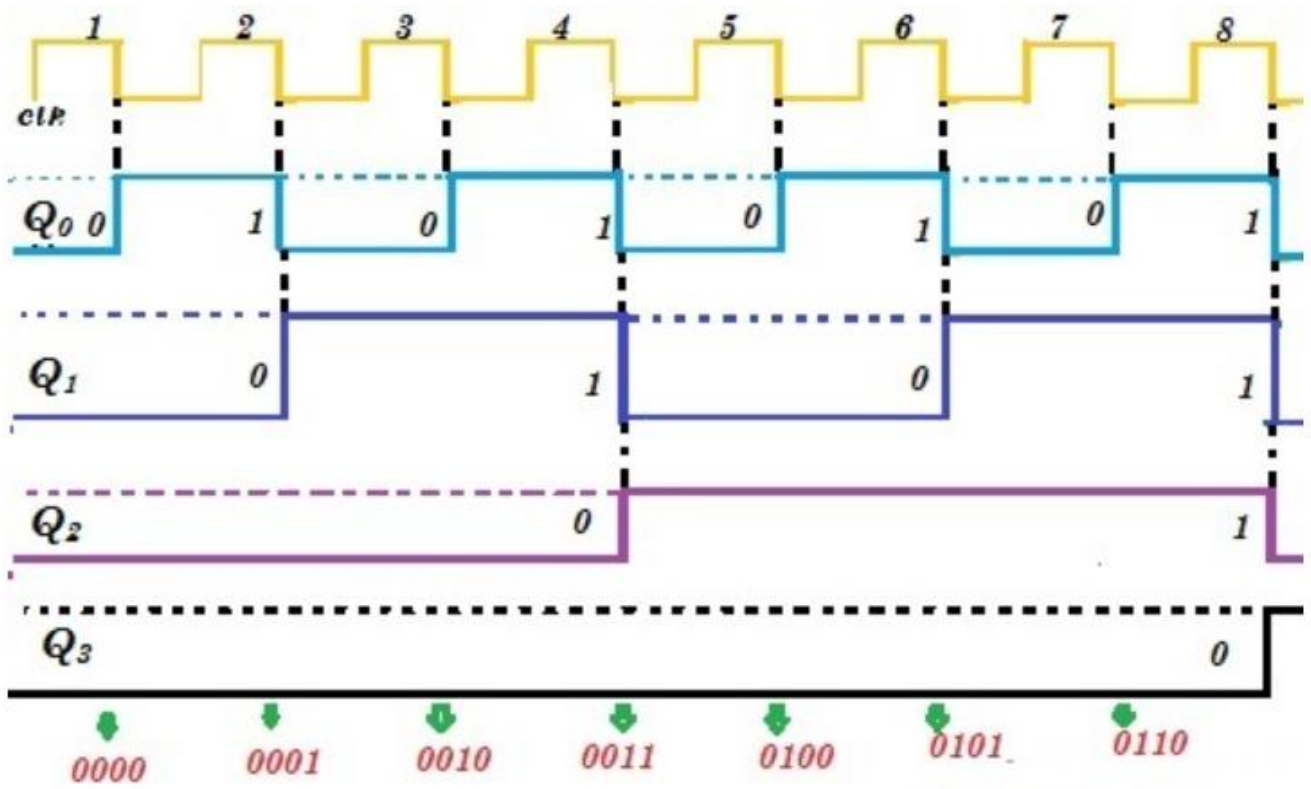
The **working of the ripple counter** can be best understood with the help of an example. Based on the number of flip flops used there are 2-bit, 3-bit, 4-bit….. ripple counters can be designed. Let us look at the working of a 4-bit **binary ripple counter** to understand the concept.

A **binary counter** can count up to 4-bit values .i.e. **4-MOD counter** can count $2^4 = 16$ values. As here n value is 4 we use 4 flip-flops. While choosing the type of flip-flop it should be remembered that Ripple counters can be designed only using those flip-flops which have a condition for toggling like in **JK and T flip flops**.

Working:

From the timing diagram, we can observe that Q0 changes state only during the negative edge of the applied clock. Initially, the flip flop is at state 0. Flip-flop stays in the state until the applied clock goes from 1 to 0. As the JK values are 1, the flip flop should toggle. So, it changes state from 0 to 1. The process continues for all pulses of the clock.

Coming to the second flip flop, here the waveform generated by flip flop 1 is given as clock pulse. So, as we can see in the timing diagram when Q0 goes transition from 1 to 0 the state of Q1 changes. Here don't consider the above clock pulse, only follow the waveform of Q0. Note that the output values of Q0 are considered as LSB and Q1 are considered as MSB. From the timing diagram, we can observe that the counter counts the values 000,001,…….111 then resets itself and starts again from 000,001,…111 until clock pulses are applied to J0 K0 flip flop.



4-bit Ripple Counter Using JK Flip flop – Time Diagram

Applications

These counters are frequently used for measurement of Time, Measurement of Frequency, Measurement of Distance, Measurement of Speed, Waveform generation, Frequency Division, Digital Computers, Direct Counting etc

Drawbacks of Ripple Counter

The carry propagation time is the time taken by a counter to complete its response to the given input pulse. As in ripple counter, the clock pulse is Asynchronous, it requires more time to complete the response.

References:

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- Modern Digital Electronics, R P Jain, 4th Ed., 2010, Tata McGraw Hill