جامعة المستقبل

نحو جامعة مستدامة

Al-Mustaqbal University - College of engineering
Department of computer engineering

Second stage

Lecture Week 6

"Decade, up-down counter"

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Objectives Decade Counter

By the end of this lecture, students will be able to

- Understand the Operation, Explain how a decade counter (mod-10) works and identify its counting sequence from 0 to 9.
- Design and Implementationa decade counter using flip-flops or ICs (e.g., 7490) and implement it in circuit diagrams or simulation tools.
- Applications, Recognize real-life applications such as digital clocks, frequency counters, and timer circuits.

Objectives Up-Down Counter

By the end of this lecture, students will be able to

- Concept Mastery: Describe how an up-down counter works and differentiate between up counting and down counting modes.
- Control Logic Design:
  Design counters with control inputs for direction (up/down) and implement with JK or T flip-flops.
  Practical Usage: Apply knowledge to build systems requiring reversible counting, such as elevator controllers or stepper motor positioning.

Decade counter

Decade counter

Decade counter is very common in today's electronics. The most commonly available IC CD7490 contains multiple flip flops to convert BCD to decimal and is incorporated as part of larger integrated circuits.

A BCD counter counts in a sequence of ten and then returns back to zero after the count of nine.

Note:

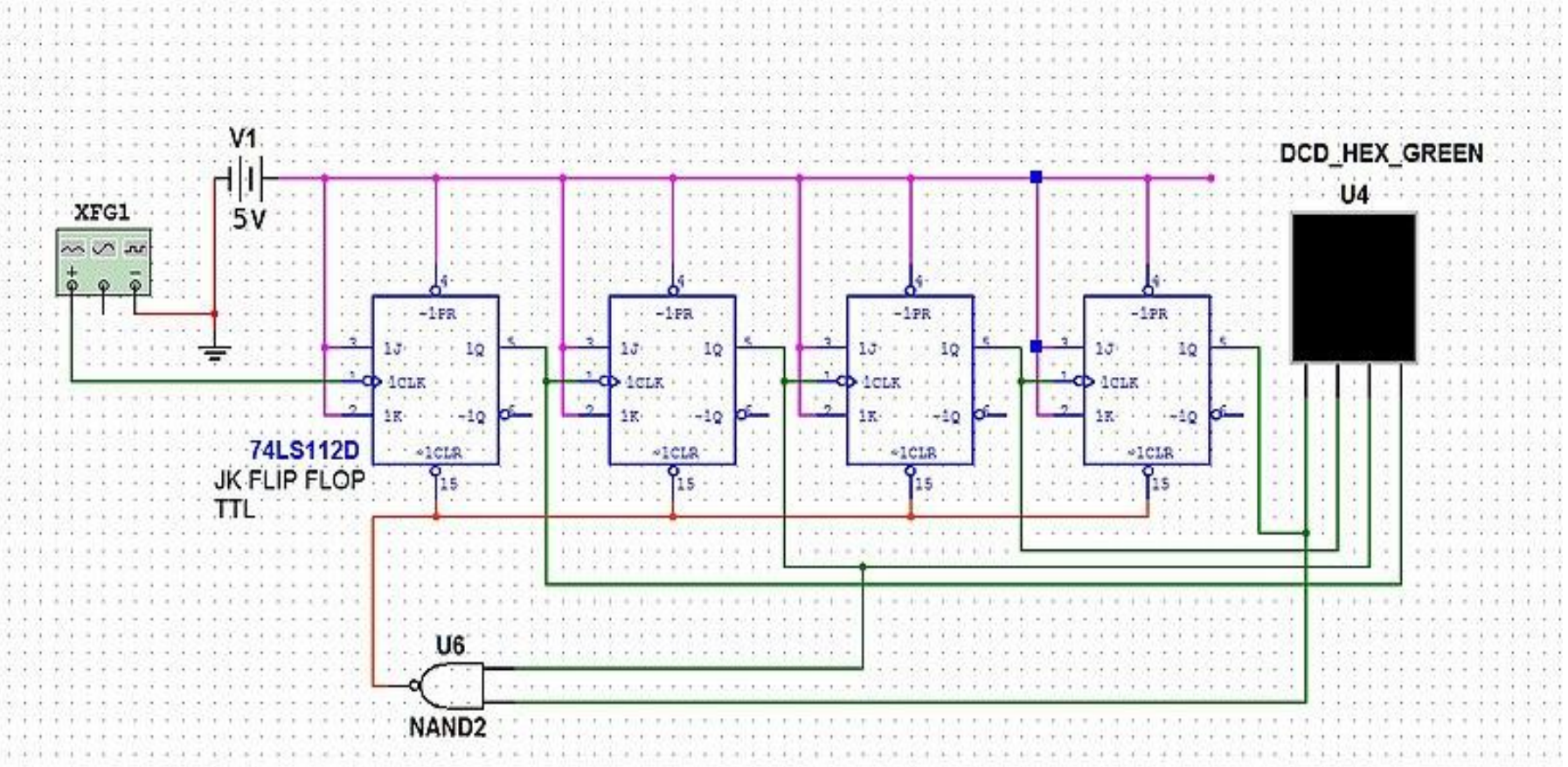
Decade counter is also known as BCD Counter.

Decade Counter Truth Table

Input Pulses	D	C	B	A
0	0	0	0	0
1	0	0	0	1
2	0	0	1	0
3	0	0	1	1
4	0	1	0	0
5	0	1	0	1
6	0	1	1	0
7	0	1	1	1
8	1	0	0	0
9	1	0	0	1
10	1	0	1	0
0	0	0	0	0 (resets)

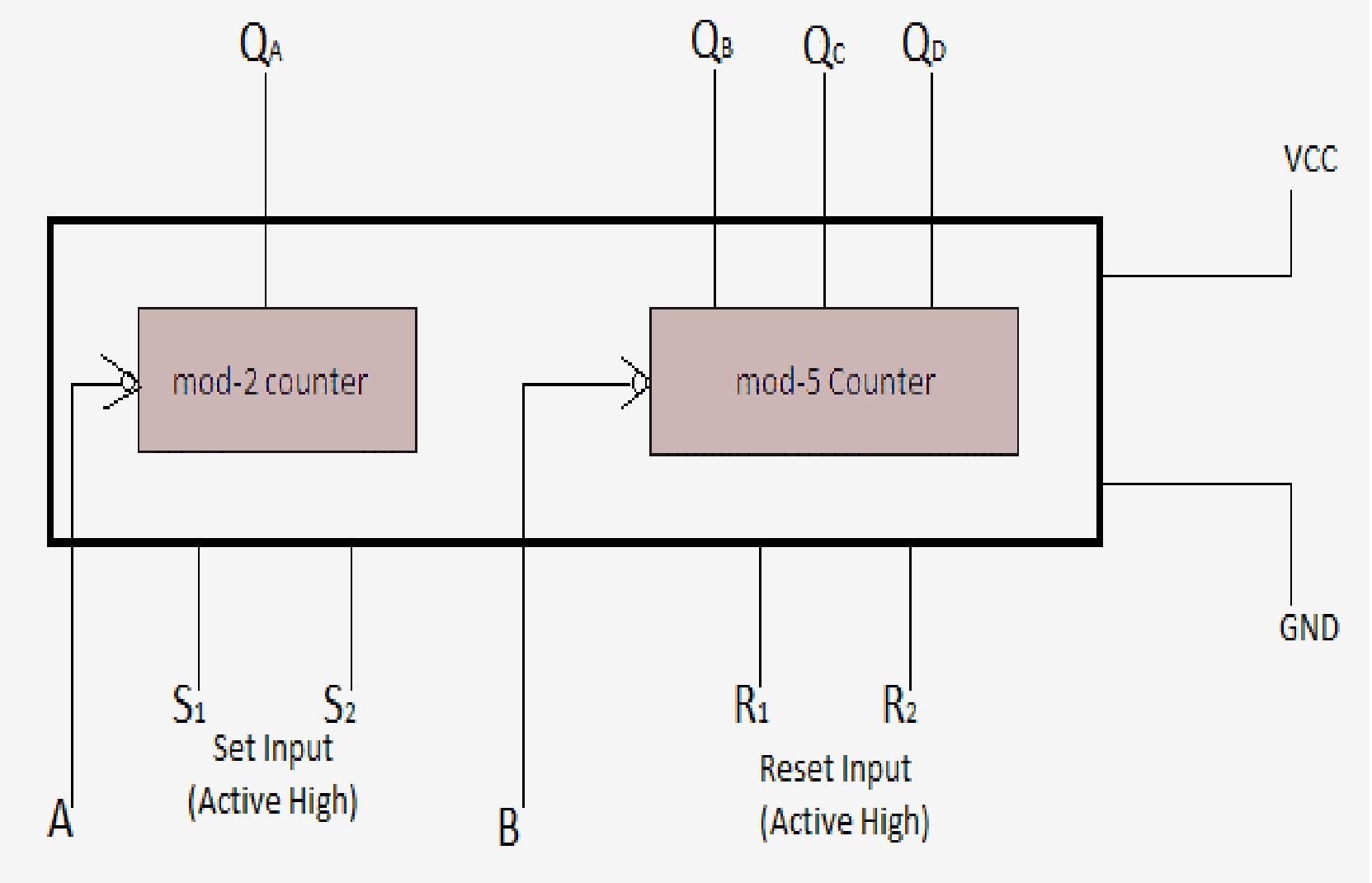
Note that this is just one example of a truth table for a decade counter. The specific truth table for a given counter will depend on the design of the counter and the specific requirements of the application.

Decade Counter Circuit Diagram



Basically, counters can be implemented quite easily using register-type circuits. Besides the decade counter, there are various other counters that are also used regularly. Let's take a look.

IC7490 Decade Counter



Counters in Digital Electronics

1. Asynchronous Counter
2. Synchronous Counter
3. Ring Counter
4. Johnson Counter
5. Decade Counter

1) Asynchronous Counter

An asynchronous counter is a simple D-Flip flop, with the output fed back as input. The output changes state for each clock input. This creates a circuit that can store one bit of information. This counter will increment once for every clock cycle and takes two clock cycles for a transition from 0 to 1 and a transition from 1 to 0 creating a new clock with a 50% duty cycle.

2) Synchronous Counter

The clock inputs of all the flip-flops are connected together and are triggered by the input pulses. Thus, all the flip-flops change state simultaneously. An advantage of synchronous counters is that there is no cumulative time delay because all flip-flops are triggered in parallel.

3) Ring Counter

A ring counter is a shift register with the output of one flip flop connected to the input of the next in a ring. Typically, a pattern consisting of a single bit is circulated so the state repeats every n-clock cycle if n flip-flops are used. It is initiated such that only one of its flip-flops is the state one while others are in their zero states

4) Johnson Counter

A Johnson counter is a kind of modified ring counter, where the output of the last stage is inverted before being fed back into the first flop. The register cycles through a sequence of bit patterns, whose length is equal to twice the length of the shift register, continuing indefinitely. It is very commonly found in digital-to-analog converters.

5) Decade Counter

The basic BCD (Decade) counter is an electronic circuit with a 4-bit binary output and an input signal (called a clock). With each clock pulse the outputs advance to the next higher value, resetting to 0000 when the output is 1001 and a subsequent clock pulse is received. Decade counters are used in clock circuits, frequency dividers, state machines, and sequencers, just to name a few applications.

What is a decade counter used for?

Decade counters are used in a variety of applications where a large number of counts are needed, but space or power constraints prevent the use of a larger counter. Some common applications for these counters include frequency division, pulse generation, and digital display systems.

Can a decade counter count down as well as up?

Yes, It can be designed to count up or down, depending on the specific requirements of the application. A counter that counts down will typically have a different truth table than a counter that counts up.

What is the maximum count value for a decade counter?

The maximum count value for a decade counter is determined by the number of output bits the counter has. For example, a counter with three output bits (like the one in the earlier example) can count up to a maximum of 2^3 = 8, before it cycles back to zero.

Can a decade counter be used as a frequency divider?

Yes, a decade counter can be used as a frequency divider by using one of the output bits as a clock signal for a subsequent stage. For example, if a decade counter is clocked at a frequency of 10 Hz, and the Q1 output is used as the clock for a subsequent stage, that stage will be clocked at a frequency of 1 Hz (once per decade).

(5 mins) HomeWork activity

https://docs.google.com/forms/d/e/1FAIpQLScYP3sKXK18lrtjgQB2N2KhIurZnqGtexHytwNEqhIRJlEOiA/viewform?usp=header

How do I choose the right decade counter for my application?!

Then Submit your answer using the QR code or the link above.

Part two

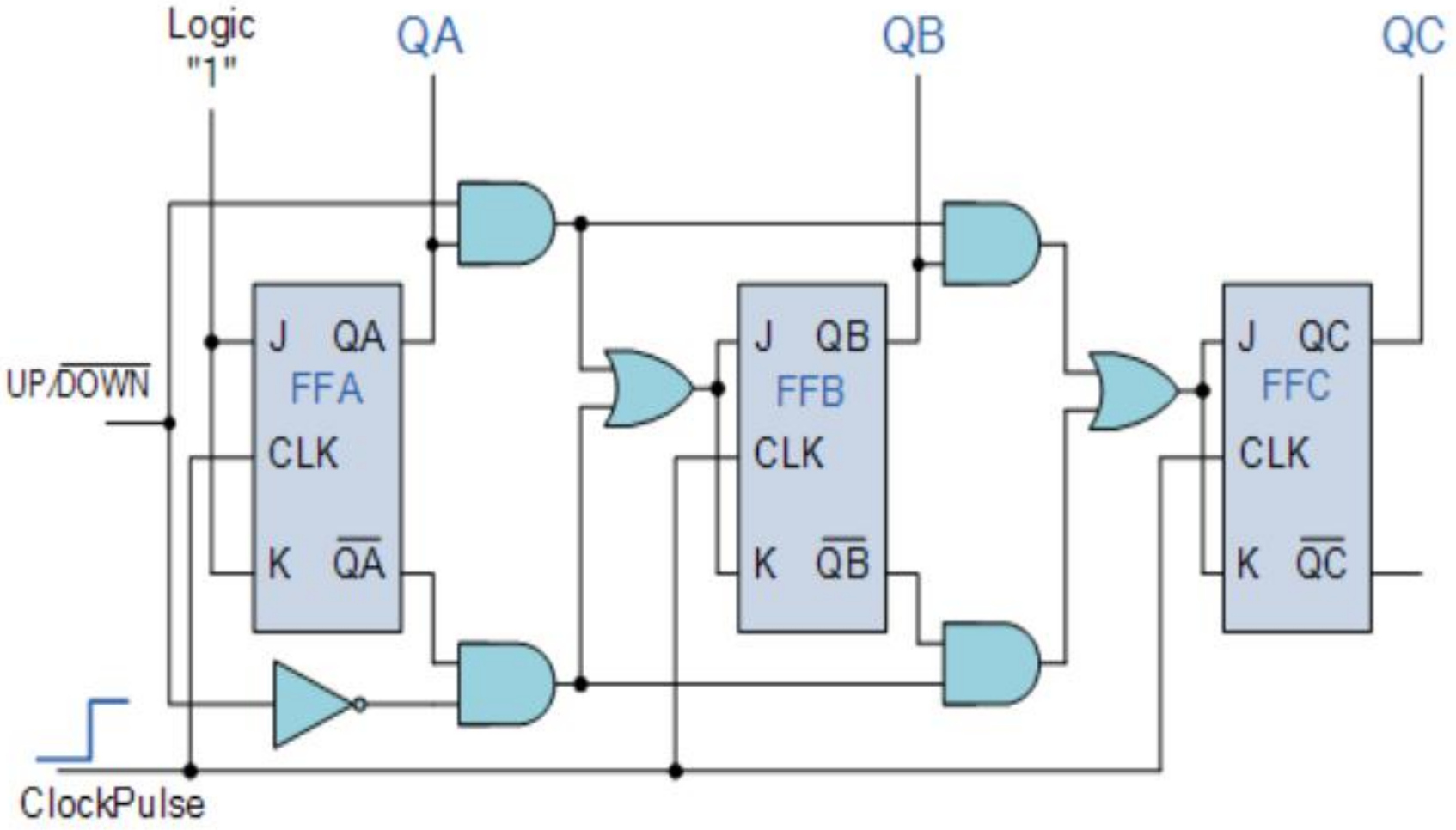
up-down counter

Bidirectional Counter

Both Synchronous and Asynchronous counters are capable of counting “Up” or counting “Down”, but their is another more “Universal” type of counter that can count in both directions either Up or Down depending on the state of their input control pin and these are known as **Bidirectional Counters**.

Bidirectional counters, also known as Up/Down counters, are capable of counting in either direction through any given count sequence and they can be reversed at any point within their count sequence by using an additional control input as shown below.

Synchronous 3-bit Up/Down Counter



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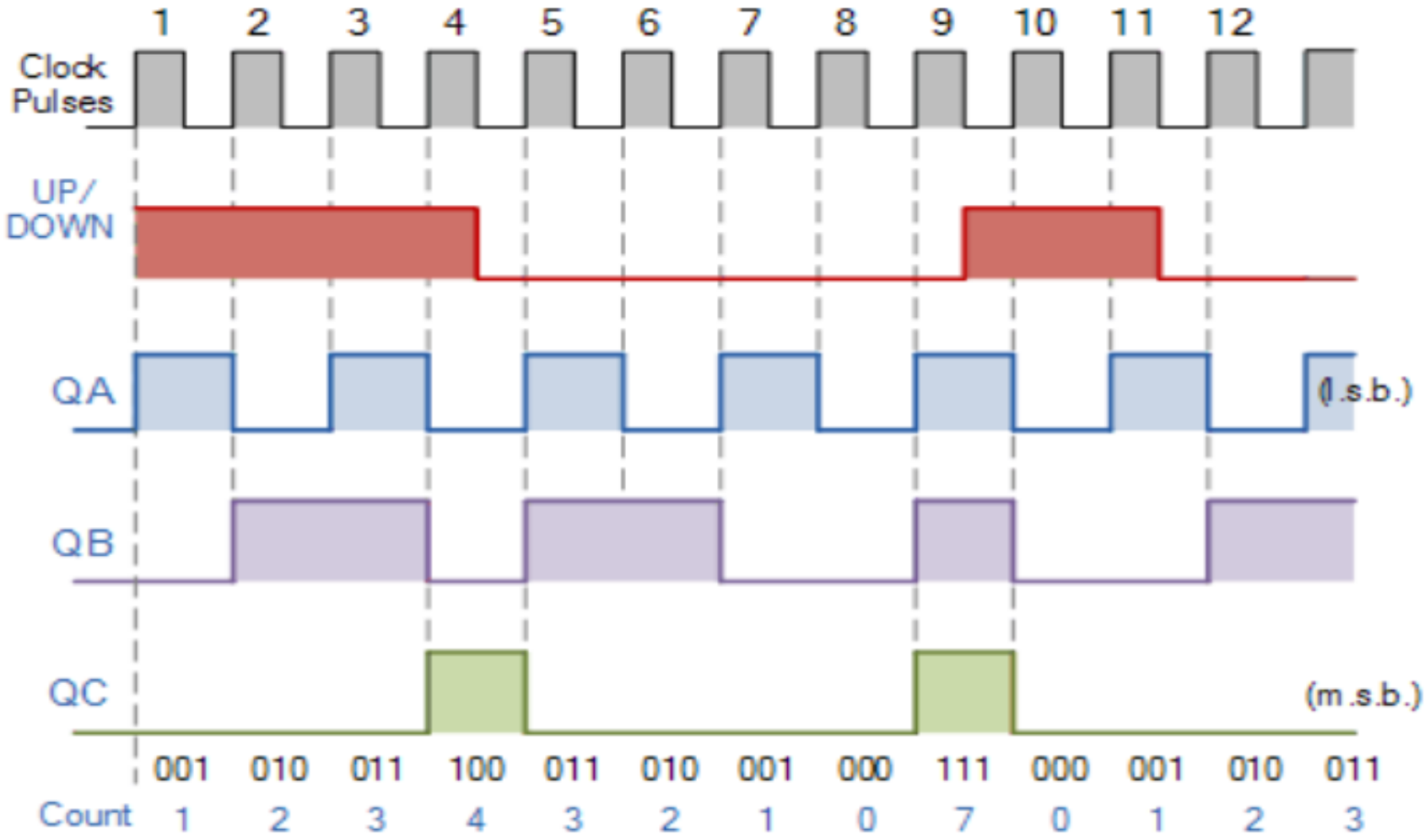
Timing Diagram Up/Down Counter



Timing Diagram Up/Down Counter

The circuit above is of a simple 3-bit Up/Down synchronous counter using JK flip-flops configured to operate as toggle or T-type flip-flops giving a maximum count of zero (000) to seven (111) and back to zero again. Then the 3-Bit counter advances upward in sequence (0,1,2,3,4,5,6,7) or downwards in reverse sequence (7,6,5,4,3,2,1,0).

Summary decade counter

Aspect	Description
Name	Decade Counter
Also Known As	Mod-10 Counter
Counting Range	0 to 9 (10 states)
Number of Flip-Flops	4 (to represent 4-bit binary numbers)
Reset Condition	Resets after count reaches 10 (binary 1010)
Types	Synchronous or Asynchronous
Operation	Counts input pulses and resets after 10th pulse
Applications	Digital clocks, frequency dividers, timers, sequence generators, counters

Summary Up/Down Counter

Feature	Description
Function	Counts upward or downward in a sequence of binary numbers
Control Input	A signal (e.g., UP/DOWN or MODE pin) determines the direction of counting
Types	Asynchronous (ripple) or Synchronous (parallel)
Applications	Digital clocks, position tracking, event counting, and elevator control systems
Direction	- **Up**: Counts from 0 to maximum (e.g., 1111 in 4-bit) - **Down**: Counts in reverse
Reset/Input	Often includes **Clear/Reset** and **Load** inputs for initializing or presetting the count

THANK YOU ☺

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END LESSON 6: DECADE, UP-DOWN COUNTER