INDRAPRASTHA INSTITUTE *of*
INFORMATION TECHNOLOGY
DELHI

Department
of
Electronics & Communication Engineering

ECE111|Digital Circuits

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Lab_9:
Ripple Counters

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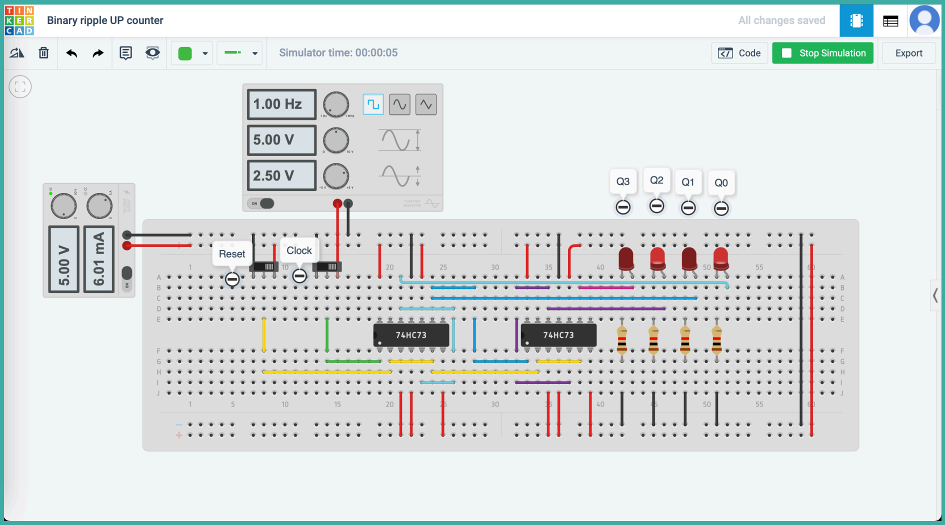
Part A. Binary Ripple Counter

Aim: Implement a Binary Ripple Counter in Tinkercad and verify its operation.

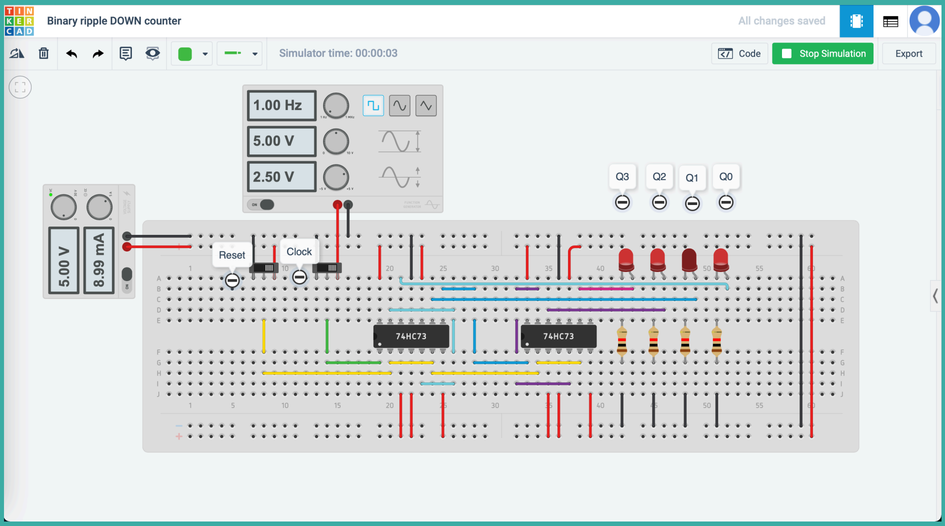
Components/ICs Used: Breadboard, Red LED, 1 kΩ Resistor, [5,5 Power Supply], Wire, slideswitch, dual JK flip-flop IC (74HC73), Function generator

Link of TINKERCAD Workspace:
UP counter: https://www.tinkercad.com/things/7VRsQYJacOD
DOWN counter: https://www.tinkercad.com/things/iBxBdBZm7A1

Circuit screenshot:
Up counter:

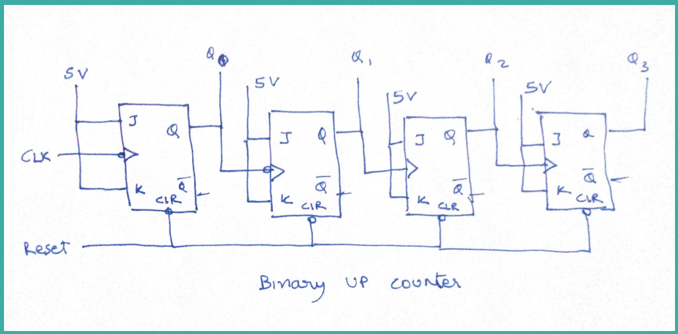


Down counter:

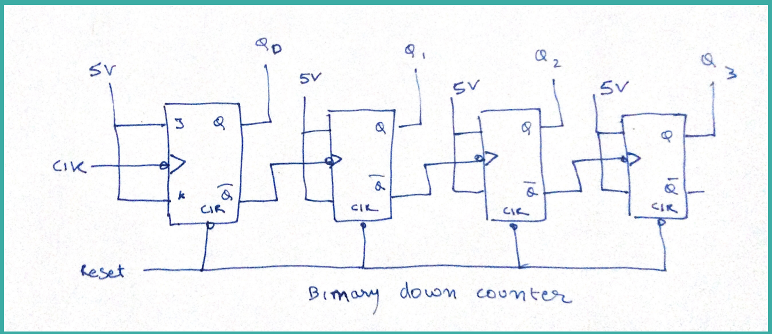


Circuit diagram:

UP counter:



DOWN counter:



Decimal to binary Truth Table:

Decimal	Q_3	Q_2	Q_1	Q_0
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
11	1	0	1	1
12	1	1	0	0
13	1	1	0	1
14	1	1	1	0
15	1	1	1	1

State Table:

For Up Counter:

		Present State	Next State
Reset	Clock	$Q_3\ Q_2\ Q_1\ Q_0$	$Q_3\ Q_2\ Q_1\ Q_0$
0	X	X X X X	0 0 0 0
1	0	Q_n	Q_n
1	1	0 0 0 0	0 0 0 1
1	1	0 0 0 1	0 0 1 0
1	1	0 0 1 0	0 0 1 1
1	1	0 0 1 1	0 1 0 0
1	1	0 1 0 0	0 1 0 1
1	1	0 1 0 1	0 1 1 0
1	1	0 1 1 0	0 1 1 1
1	1	0 1 1 1	1 0 0 0
1	1	1 0 0 0	1 0 0 1
1	1	1 0 0 1	1 0 1 0
1	1	1 0 1 0	1 0 1 1
1	1	1 0 1 1	1 1 0 0
1	1	1 1 0 0	1 1 0 1
1	1	1 1 0 1	1 1 1 0
1	1	1 1 1 0	1 1 1 1
1	1	1 1 1 1	0 0 0 0

For Down Counter:

		Present State	Next State
Reset	**Clock**	$Q_3\ Q_2\ Q_1\ Q_0$	$Q_3\ Q_2\ Q_1\ Q_0$
0	X	X X X X	1 1 1 1
1	0	Q_n	Q_n
1	1	1 1 1 1	1 1 1 0
1	1	1 1 1 0	1 1 0 1
1	1	1 1 0 1	1 1 0 0
1	1	1 1 0 0	1 0 1 1
1	1	1 0 1 1	1 0 1 0
1	1	1 0 1 0	1 0 0 1
1	1	1 0 0 1	1 0 0 0
1	1	1 0 0 0	0 1 1 1
1	1	0 1 1 1	0 1 1 0
1	1	0 1 1 0	0 1 0 1
1	1	0 1 0 1	0 1 0 0
1	1	0 1 0 0	0 0 1 1
1	1	0 0 1 1	0 0 1 0
1	1	0 0 1 0	0 0 0 1
1	1	0 0 0 1	0 0 0 0
1	1	0 0 0 0	1 1 1 1

Observations/Results: The output matches with the truth table and the LEDs glow showing 0 to 15 in binary.

Justifications: The up and down counter work by taking the output of a flipflop as input to another flipflop. This works as a frequency divider and the frequency is halved each flipflop. The 4 outputs appear to count in binary.

Applications of the experiment: counters have following applications:

- Frequency counters
- Digital clocks
- Analog to digital convertors.
- With some changes in their design, counters can be used as frequency divider circuits. The frequency divider circuit is that which divides the input frequency exactly by ‘2’.
- In time measurement. That means calculating time in timers such as electronic devices like ovens and washing machines.

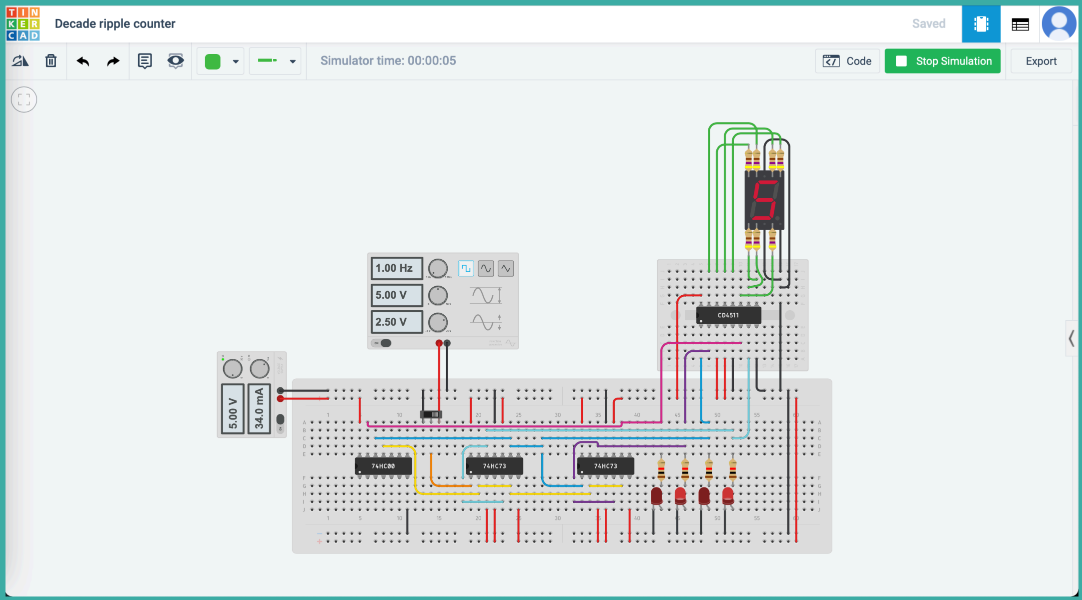
Part B. Decade Ripple Counter

Aim: Implement a Decade Ripple Counter in Tinkercad and verify its operation.

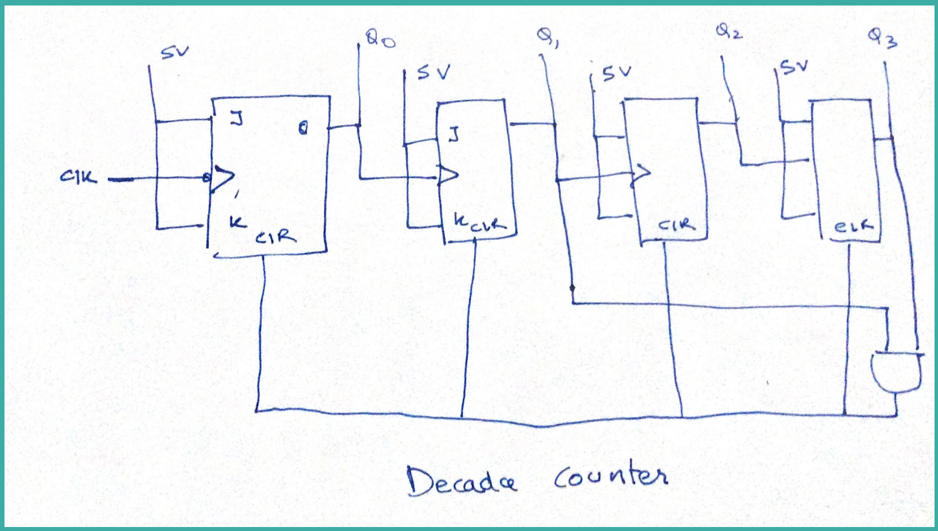
Components/ICs Used: Breadboard, Red LED, 1 kΩ Resistor, [5,5 Power Supply], Wire, slideswitch, dual JK flip-flop IC(74HC73), NAND IC(74HC00), seven segment decoder(CD4511), Function generator

Link of TINKERCAD Workspace: https://www.tinkercad.com/things/0MnEOXiPRq6

Circuit screenshot:



Circuit diagram:



Decimal to binary Truth Table:

Decimal	Q_3	Q_2	Q_1	Q_0
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

State Table:

	Present State	Next State
Clock	$Q_3\ Q_2\ Q_1\ Q_0$	$Q_3\ Q_2\ Q_1\ Q_0$
0	Q_n	Q_n
1	0 0 0 0	0 0 0 1
1	0 0 0 1	0 0 1 0
1	0 0 1 0	0 0 1 1
1	0 0 1 1	0 1 0 0
1	0 1 0 0	0 1 0 1
1	0 1 0 1	0 1 1 0
1	0 1 1 0	0 1 1 1
1	0 1 1 1	1 0 0 0
1	1 0 0 0	1 0 0 1
1	1 0 0 1	0 0 0 0

Observations/Results: The output matches with the truth table and the 7 segment display shows from 0 to 9.

Justifications: This is an up counter with the reset connected to Q3 AND Q1. So when the Q3 and Q1 are both 1 (at decimal 10) the up counter resets to 0 0 0 0.

Applications of the experiment: counters have following applications:

- Decade counters are used in clock circuits, frequency dividers, state machines, and sequencers.
- Clock division.
- Integrated oscillator.
- In frequency counting circuits