CSE332 Lab 5

Name: Nazmul Hasan
ID: 1911742042
Course: CSE332L
Section: 3
Experiment Name: Design of a 3-bit Binary Up-Down counter.

Table:

M	A	B	C	Q_A	Q_B	Q_C	T_A	T_B	T_C
0	0	0	0	0	0	1	0	0	1
0	0	0	1	0	1	0	0	1	1
0	0	1	0	0	1	1	0	0	1
0	0	1	1	1	0	0	1	1	1
0	1	0	0	1	0	1	0	0	1
0	1	0	1	1	1	0	0	1	1
0	1	1	0	1	1	1	0	0	1
0	1	1	1	0	0	0	1	1	1
1	0	0	0	1	1	1	1	1	1
1	0	0	1	0	0	0	0	0	1
1	0	1	0	0	0	1	0	1	1
1	0	1	1	0	1	0	0	0	1
1	1	0	0	0	1	1	1	1	1
1	1	0	1	1	0	0	0	0	1
1	1	1	0	1	0	1	0	1	1
1	1	1	1	1	1	0	0	0	1

By using 4 variable K-map, we can find the equation for T_A, T_B, and T_C.

K-map for T_A:

T_A	B'C'	B'C	BC	BC'
M'A'	0	0	1	0
M'A	0	0	1	0
MA	1	0	0	0
MA'	1	0	0	0

$T_A = MB'C' + M'BC$

K-map for T_B:

T_B	B'C'	B'C	BC	BC'
M'A'	0	1	1	0
M'A	0	1	1	0
MA	1	0	0	1
MA'	1	0	0	1

$T_B = M'C + MC'$

K-map for T_C:

T_C	B'C'	B'C	BC	BC'
M'A'	1	1	1	1
M'A	1	1	1	1
MA	1	1	1	1
MA'	1	1	1	1

$T_C = 1$

Discussion: In this lab our objective was to design a 4-bit a binary up-down counter. In our lab class, we implemented a 3-bit binary up down counter with a mode control. A counter that follows the binary number sequence is called a binary counter. We have used 'M' as mode control bit. When M is low (M=0), the counter counts downward and, when M is high (M=1), the counter counts upward. Variables A, B and C are used to represent states from 0 to 7. For each state, there is a next state. Q_A, Q_B and Q_C represent next states.

To design the up-down counter we have used T flip flops. The T flip flops act as a toggle switch. When the input is 0, there is no change in the output of the T flip-flops. It retains the previous value. But when the input is 1, the output is complemented. A XOR gate combined with a D flip-flop is used to create a T flip-flop.

A circuit excitation table is created where,

$T_A = A \text{ XOR } Q_A$, $T_B = B \text{ XOR } Q_B$ and $T_C = C \text{ XOR } Q_C$

After that, we have used K-map to find the input equations for T_A, T_B and T_C. The input equations are:

$T_A = MB'C' + M'BC$, $T_B = M'C + MC'$ and $T_C = 1$

With this input equations for three T flip flips we can create our 3-bit binary up down counter. From each flip flop output we will get three output bits Q_A, Q_B and Q_C that represent the next states.