2C – 115104 – Mbugua Nathan Ng'ethe

Four Way Traffic Light System

The Different States

There are **six states** at which a traffic light can be in. This can be observed from the **Single Traffic Light Circuit**. These states are associated with a corresponding binary digit as shown in the diagram below:

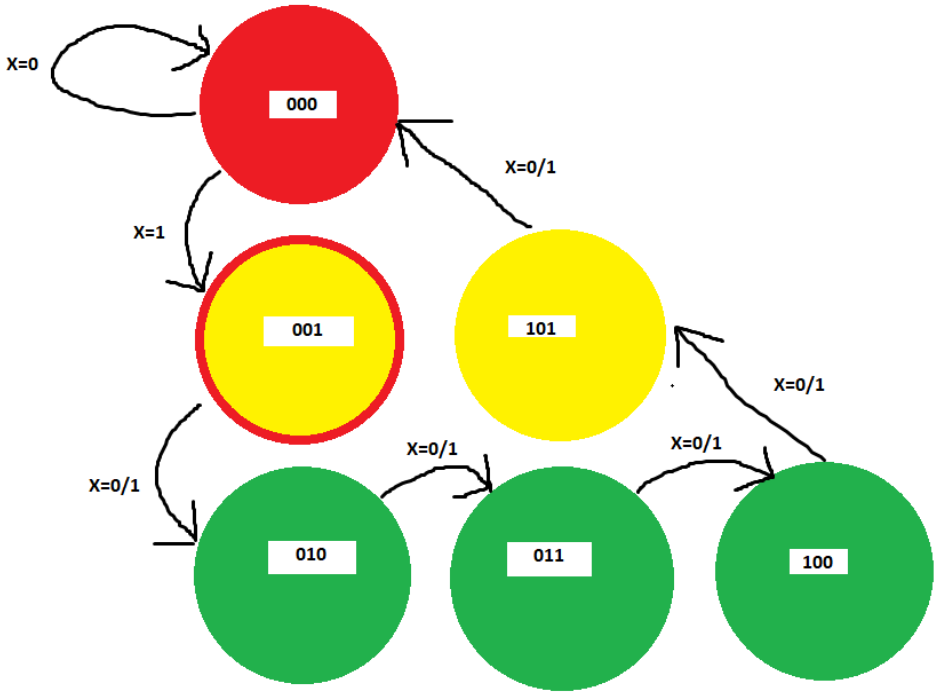

Figure 1: State Diagram

Explanation

- **X** represents the input, which on the combined circuit will be set based on whether the specific traffic light is supposed to be active or not.
- When **X=0**, the light remains **red**. When **X=1**, then the light transitions **to "Red and Yellow"**. This state is represented by the number **001** and both the red and yellow lights are on.
- From here, whether the input is 0 or 1, the light turns green and stays green for **three ticks** as would be observed on an in-world traffic light whereby the green light, once set, stays on for some time. These three states of green are represented as **010**, **011**, and **100**.
- The light will then move to yellow regardless of the input. This yellow is represented as **101**. After this the binary number should reset to **000** and thus return the light to red.
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State Table

Current State			Input	Next State		
A	B	C		A	B	C
0	0	0	0	0	0	0
0	0	0	1	0	0	1
0	0	1	0	0	1	0
0	0	1	1	0	1	0
0	1	0	0	0	1	1
0	1	0	1	0	1	1
0	1	1	0	1	0	0
0	1	1	1	1	0	0
1	0	0	0	1	0	1
1	0	0	1	1	0	1
1	0	1	0	0	0	0
1	0	1	1	0	0	0
1	1	0	0	0	0	0
1	1	0	1	0	0	0
1	1	1	0	0	0	0
1	1	1	1	0	0	0

Note: To explain the different parts of the circuit, I am going to start from the how the traffic lights are controlled and move backwards from there.

D Flip Flop

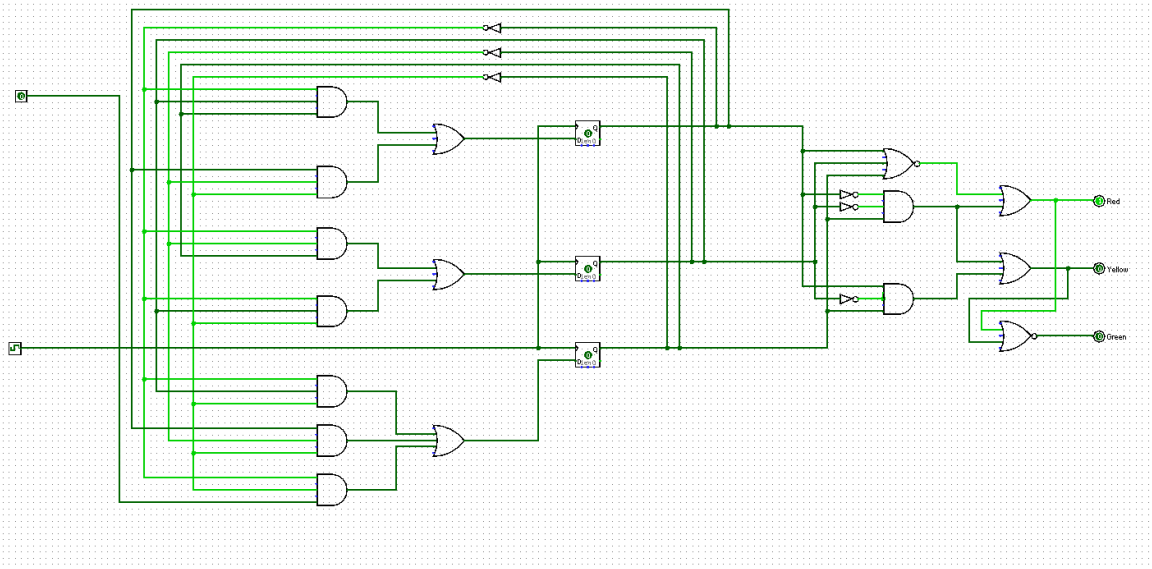

Figure 2: D Flip Flop

This has a high input, X, as discussed above. The purpose of this flip flop is to simply shift between the different states of a single traffic light. It gives an output of the six states also discussed above. From this flip flop, one can observe as the traffic lights change from red, to yellow, to green and back to red via yellow. This component is at the edge of the combined circuit.

Multiplexer

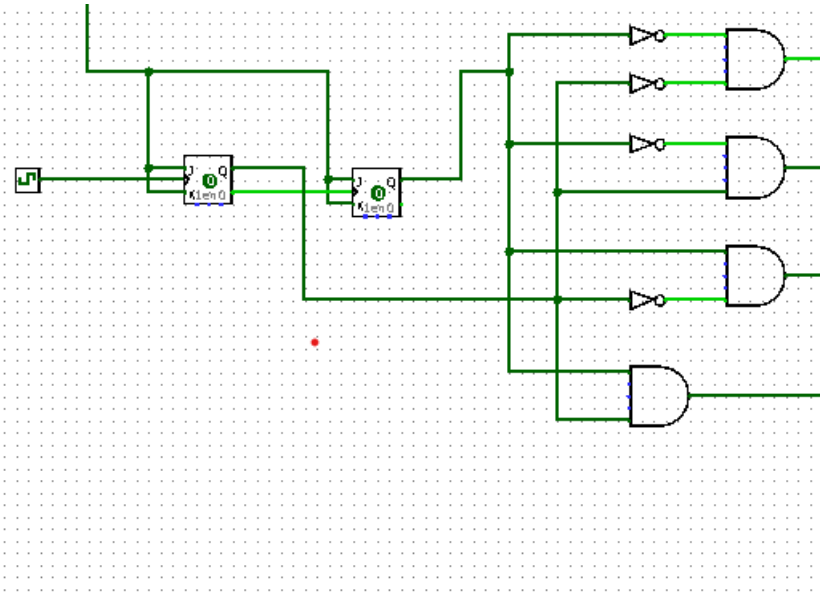

Figure 3:Multiplexer

This is needed to swap between the four traffic lights in the circuit. The table below describes how the traffic light that should be active is determined based on the inputs that the multiplexer receives.

A	B	Traffic Light Number
0	0	1
0	1	2
1	0	3
1	1	4

2-Bit Counter

This tells the multiplexer when to swap between the traffic lights. In short it feeds the multiplexer with the necessary input to swap between the traffic light pathways.

MOD-6 Counter

This allows us to move through the different states of the traffic light. Since we have six states and the highest state is 101, a MOD 6 counter is suitable since it contains six counter states from 0 to 6.

The counter I used is a synchronous counter and uses three JK flip flops.

The table below specifies a summary of the counter's design:

Input pulse	Counter Staes			Flip Flop Inputs					
Count	A	B	C	$J_{A`}$	K_A	J_B	K_B	J_C	K_C
0	0	0	0	1	X	0	X	0	X
1	1	0	0	X	1	1	X	0	X
2	0	1	0	1	X	X	0	0	X
3	1	1	0	X	1	X	1	1	X
4	0	0	1	1	X	0	X	X	0
5	1	0	1	X	1	0	X	X	1
6(0)	0	0	0						