Swinburne University of Technology

COS10004 – COMPUTER SYSTEMS

Semester: Fall 2022

Assignment 1:

Music Player

Huynh Thanh Thy 103805499

Class: COS10004

Lecturer: Dr. Minh Quang Nguyen

Description of the circuit

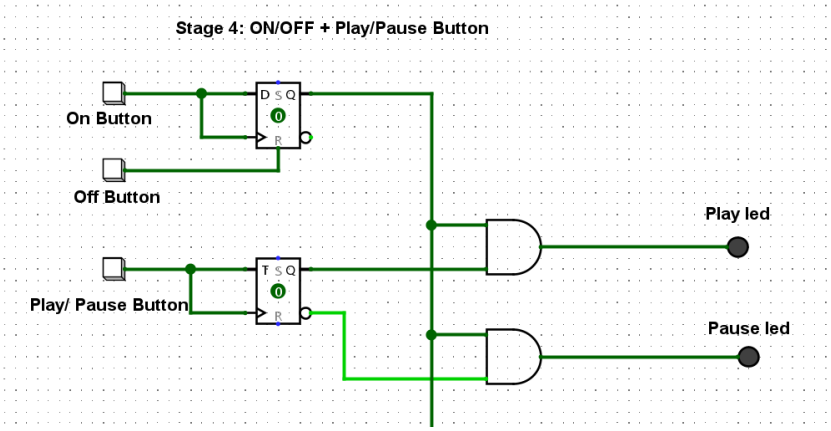
This is the music player which demonstrates by the circuits on Logism. It has several function such as turn on, turn off the music player, control the volume settings and skip track. Components are used in my circuit: Logic gates, wires, Hex Displays, 8-LED bar graph, buttons, splitters, flip flops.

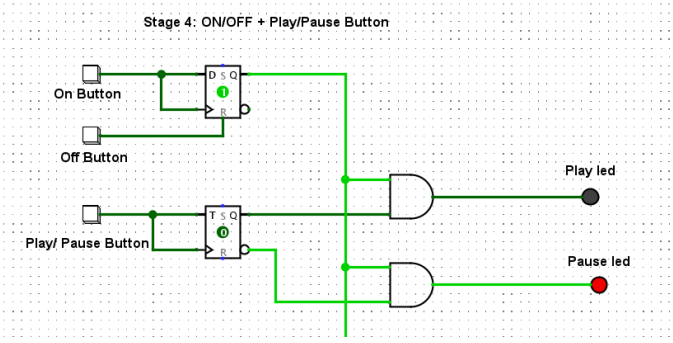
Design outline

I divided the music player in this assignment into three parts:

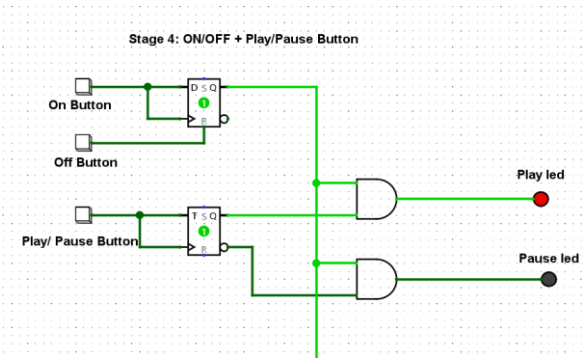
1. **ON/OFF to Play/Pause state**

This is included On and Off Button, a Play/Pause Button. The music player only can work after turning on, otherwise other parts will not work, such as increasing/ decreasing the volume or skipping track.

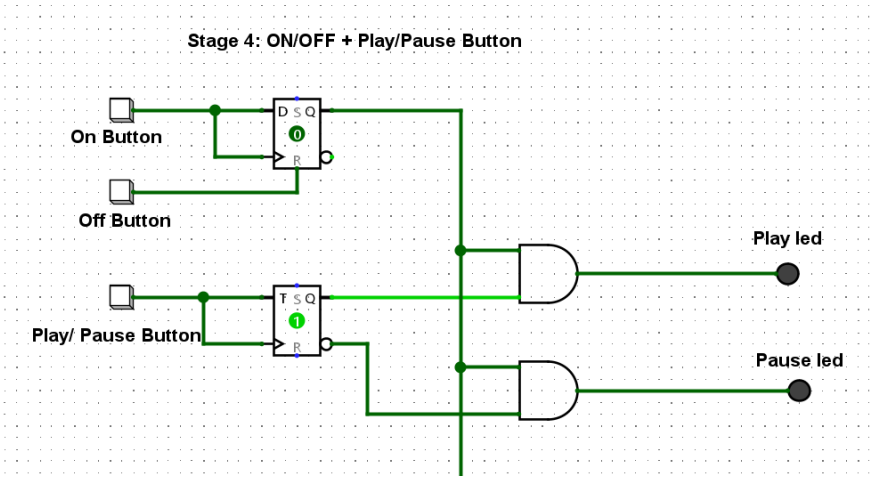




Pic 1.1. When pressing the ON Button, the music player turns on and enters the Pause state (Pause led is on)



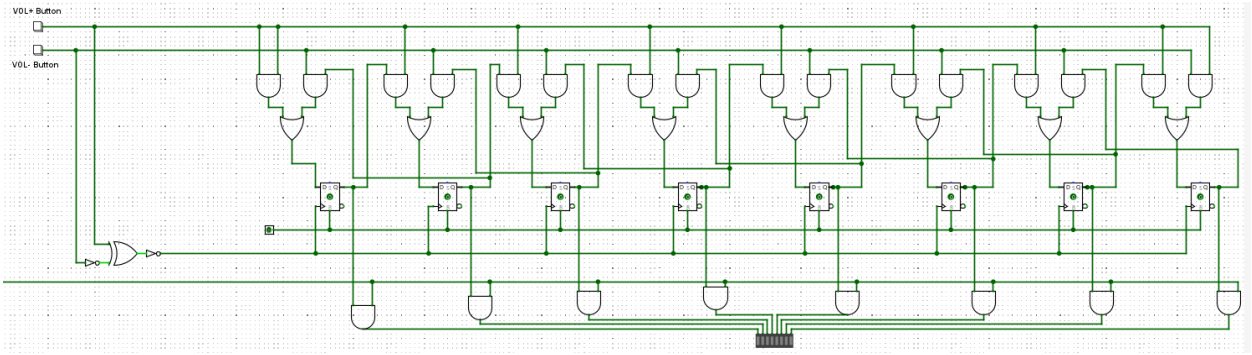
Pic 1.2. When pressing the Play/Pause Button, the music player enters the Play state (Play led is on)



Pic 1.3. When pressing the OFF Button, the music player shut down and turn off all the leds.

2. Volume control and display

This includes an 8 LED bar graph and two buttons (Decrease and Increase buttons)

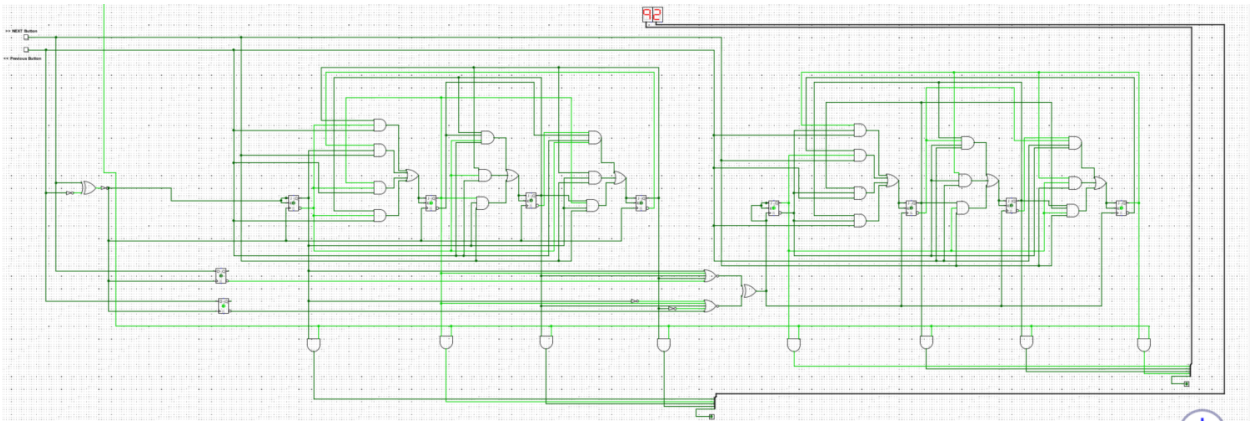


I designed the volume control based on the bidirectional shift register. I modified it because the volume control only can increase the volume (turn on the led) from the left to the right and decrease the volume (turn off the led) from the right to the left.

Because the music player has 8 volume level, there are 8 D flip flop to present each level. The inputs of the flips flops are others flip flops outputs.

3. Track skipping control and display

This is included Previous and Next buttons as well as a two decimal digit display to show the track number.



First, I design one MOD 10 synchronous up/down counter. Once it reaches the count 9 (1001 in binary), the counter goes back to 0000 instead of continuing to 1010. In addition, when it reaches the count 0 (0000 in binary), the counter goes back to 1001.

- Determine the number of flip flops required ($N <= 2^n$)

  $10 < 2^4$ (16) → n = 4

  I use 4 JK flip flops to design MOD 10 up/down counter

- If M = 1 → Up counter, else M = 0 → Down counter
- Q_4 is Most Significant Bit and Q_1 is Least Significant Bit.
- Circuit excitation table:

	Previous Stage				Next stage							
M	Q_4	Q_3	Q_2	Q_1	Q_4	Q_3	Q_2	Q_1	$J_4 = K_4$	$J_3 = K_3$	$J_2 = K_2$	$J_1 = K_1$
1	0	0	0	0	0	0	0	1	0	0	0	1
1	0	0	0	1	0	0	1	0	0	0	1	1
1	0	0	1	0	0	0	1	1	0	0	0	1
1	0	0	1	1	0	1	0	0	0	1	1	1
1	0	1	0	0	0	1	0	1	0	0	0	1
1	0	1	0	1	0	1	1	0	0	0	1	1
1	0	1	1	0	0	1	1	1	0	0	0	1
1	0	1	1	1	1	0	0	0	1	1	1	1
1	1	0	0	0	1	0	0	1	0	0	0	1
0	1	0	0	0	0	1	1	1	1	1	1	1
0	0	1	1	1	0	1	1	0	0	0	0	1
0	0	1	1	0	0	1	0	1	0	0	1	1
0	0	1	0	1	0	1	0	0	0	0	0	1
0	0	1	0	0	0	0	1	1	0	1	1	1
0	0	0	1	1	0	0	1	0	0	0	0	1
0	0	0	1	0	0	0	0	1	0	0	1	1
0	0	0	0	1	0	0	0	0	0	0	0	1
0	0	0	0	0	1	0	0	0	1	1	1	1

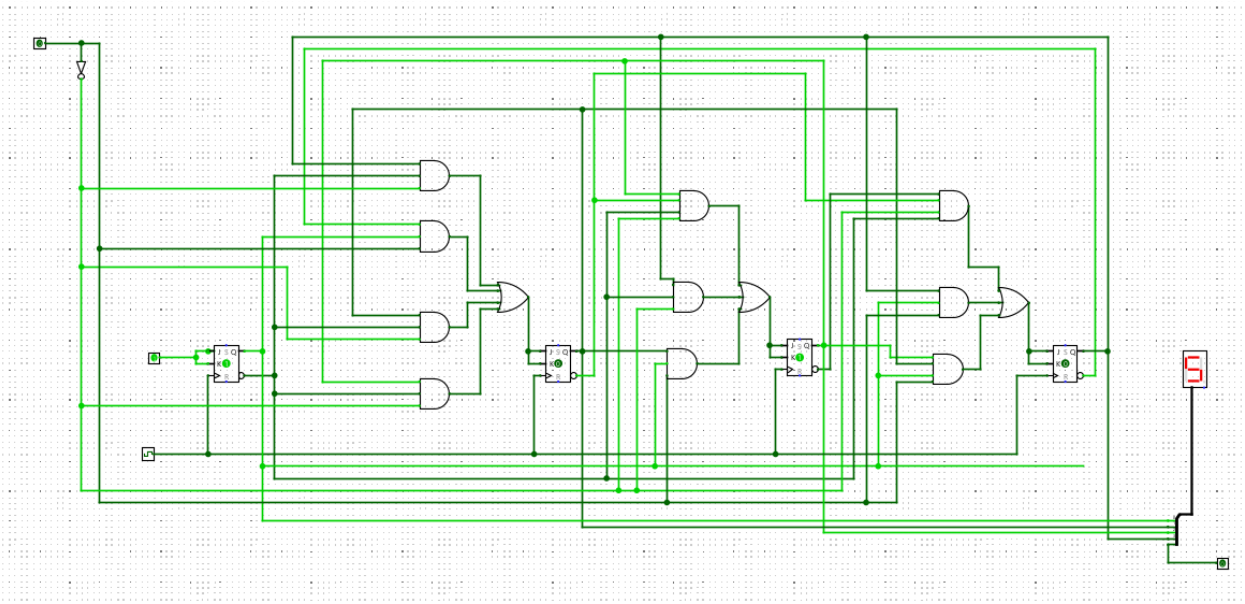
After using K-map, the expression is:

$J_1 = K_1 = 1$

$J_2 = K_2 = (Q_4 \cdot Q_1' \cdot M') + (Q_4' \cdot Q_1 \cdot M) + (Q_2 \cdot Q_1' \cdot M') + (Q_3 \cdot Q_1' \cdot M')$

$J_3 = K_3 = (Q_3 \cdot Q_2' \cdot Q_1' \cdot M') + (Q_4 \cdot Q_1' \cdot M') + (Q_2 \cdot Q_1 \cdot M)$

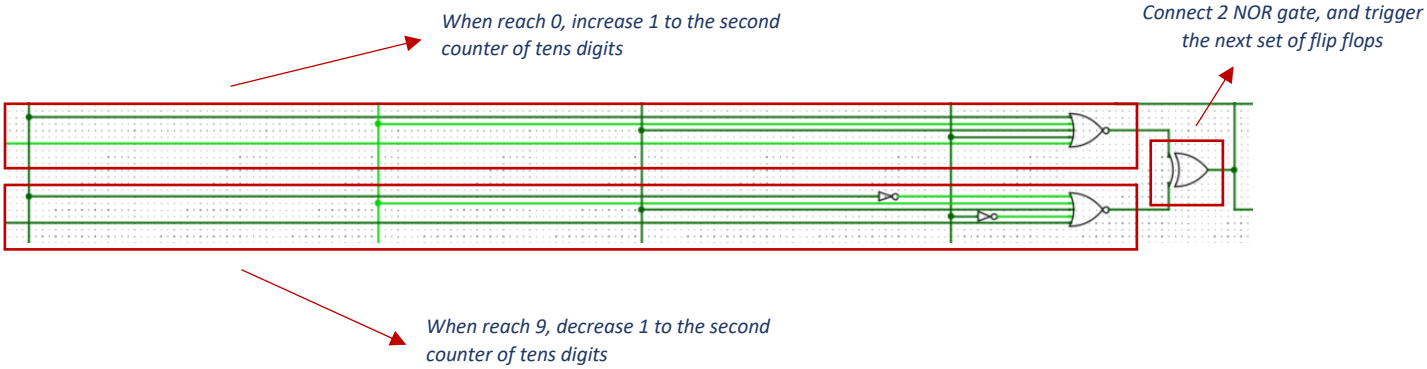
$J_4 = K_4 = (Q_3' \cdot Q_2' \cdot Q_1' \cdot M') + (Q_4 \cdot Q_1 \cdot M) + (Q_3 \cdot Q_2 \cdot Q_1 \cdot M)$



- Connect 2 MOD-10 counters

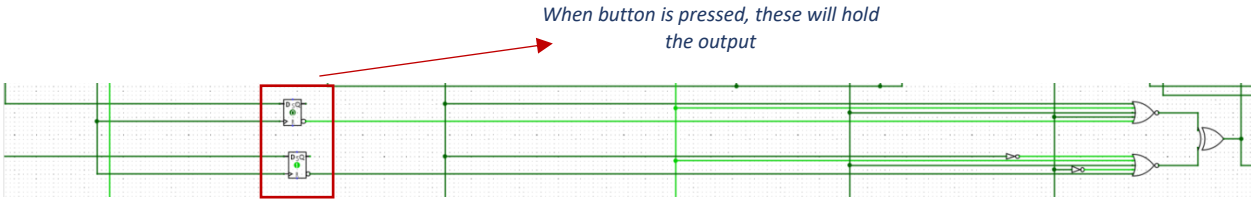
The 2 NOR gates and 1 XOR gate: When the unit digits (first mod 10 counter) reach 0, it will trigger the tens digit to increase 1. And when the unit digits (first mod 10 counter) reaches 9 (1001), it will trigger the tens digit to decrease 1

- The 5 inputs of NOR gates are the outputs Q of 4 JK flip flops and the click of the buttons. Only when all inputs of NOR gates = 0, the output will be 1.
- The XOR gate connects the outputs of 2 NOR gates, only one of them equals 1, it will trigger the clock of the second MOD 10 counter



The 2 D flip flops: The output of the pressed button is 1, and when the button is released, it will be 0, which makes the output unstable, so I use the D flip flop to hold the output of pressing the button.

- When press the Next button, the tens digits will increase 1 only if it reaches 0 and will not trigger when it reaches 9 or affect the count down.
- When press the Previous button, the tens digits will decrease 1 only if it reaches 9 and will not trigger when it reaches 0 or affect the count up.

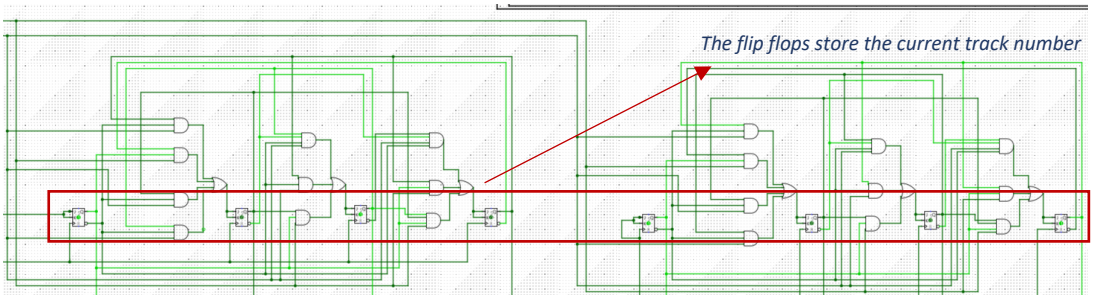


Stage 5: Store data into flip flops

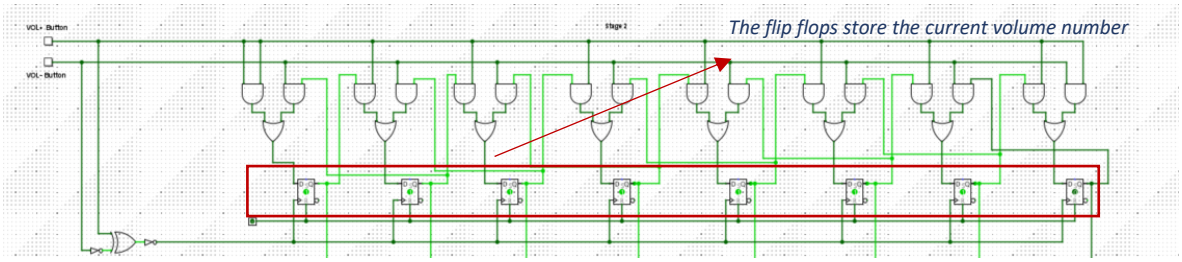
❖ **Stage 5A:** Because I used flip flops in previous stage, it already stores the data

When switched from either ON state to the OFF state, the circuit will store:

- the current track number in a register

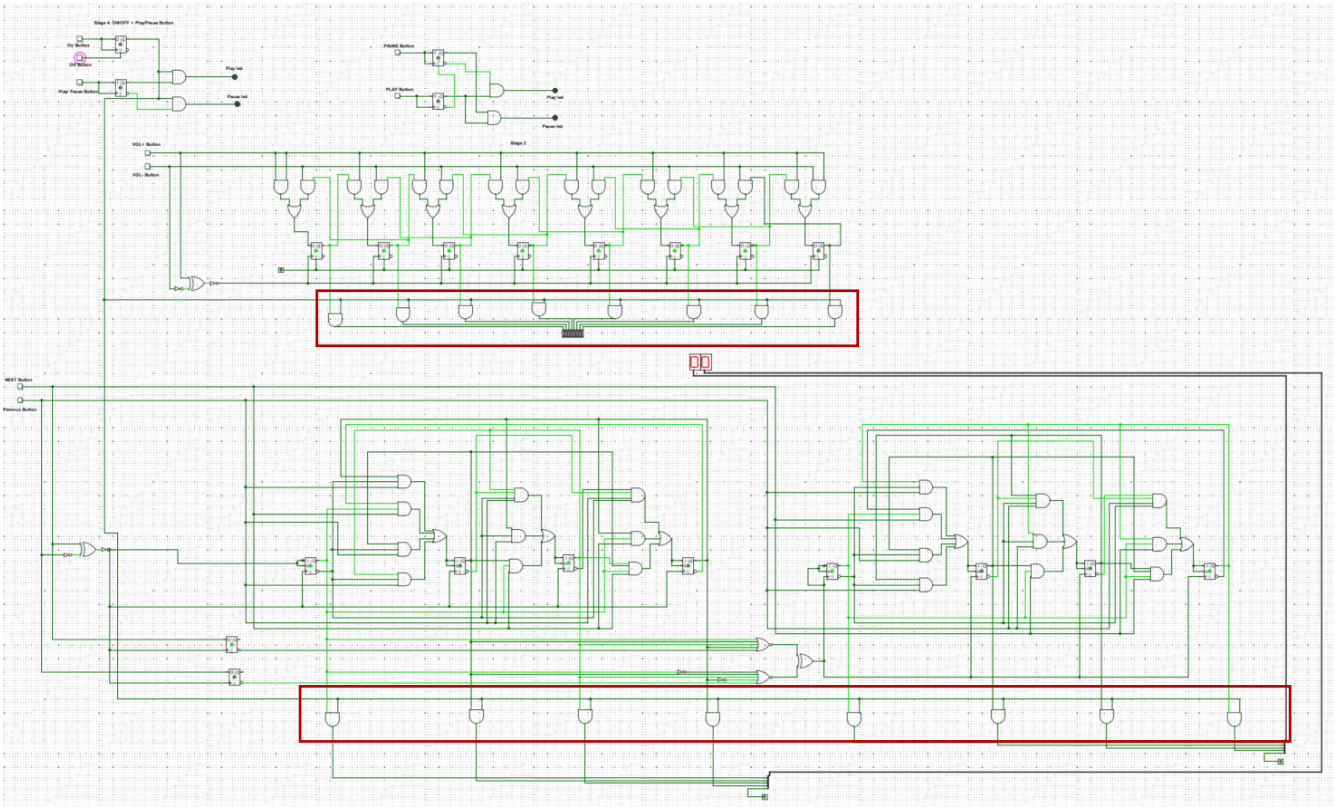


- the current volume in a register

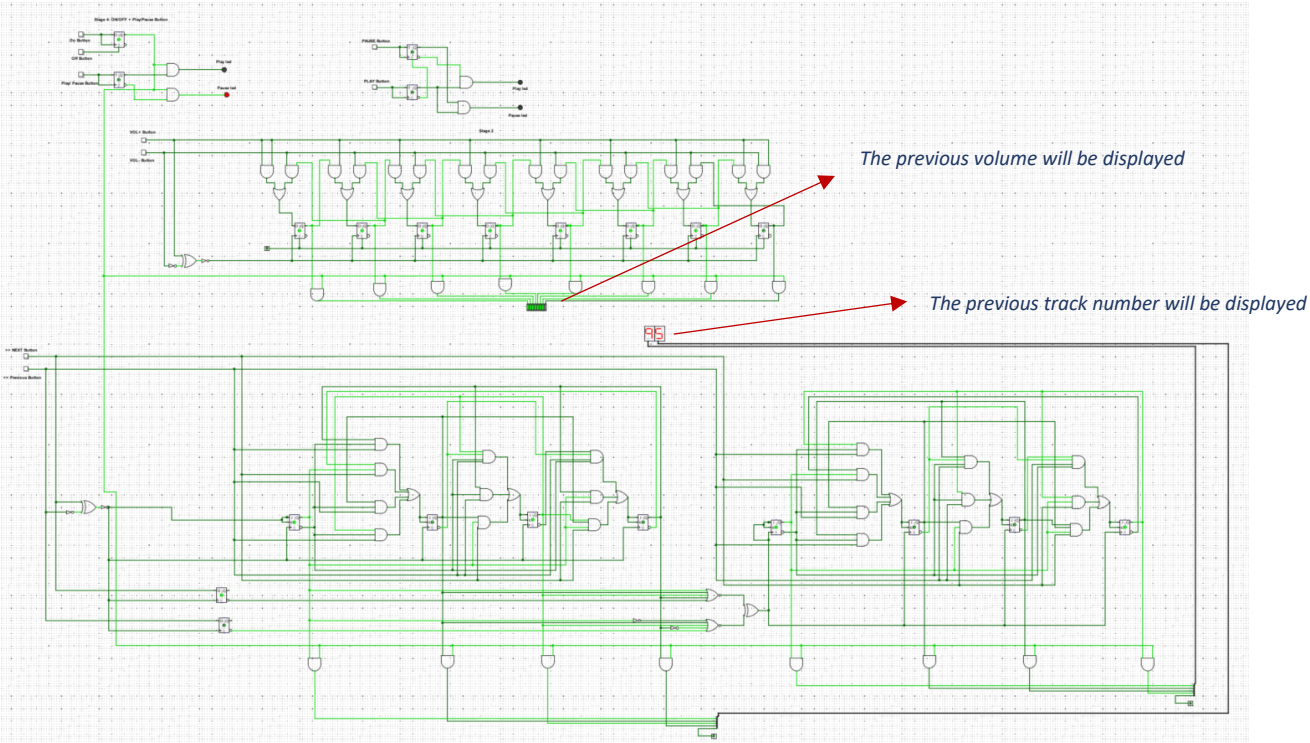


❖ **Stage 5B:** When pressing OFF button, all the leds and the track number will turn off. When turn on again, the data which is stored in the flip flops will display.

I use the AND gates to connect the ON button and the circuits of volume control as well as the track number splitters. Thus, when turn off the music player, the data still stores in flip flops but it cannot be displayed.



Pic 5.1 When pressing the OFF Button, the music player shut down and turn off all the leds as well as the track number.

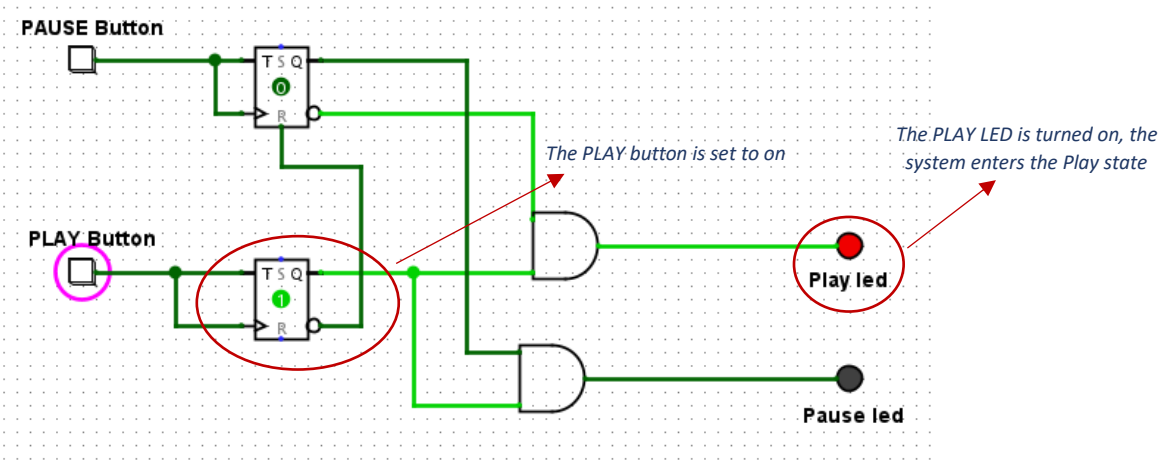


Pic 5.2 When pressing the ON Button, the music player turns on and the previous volume and track will be displayed

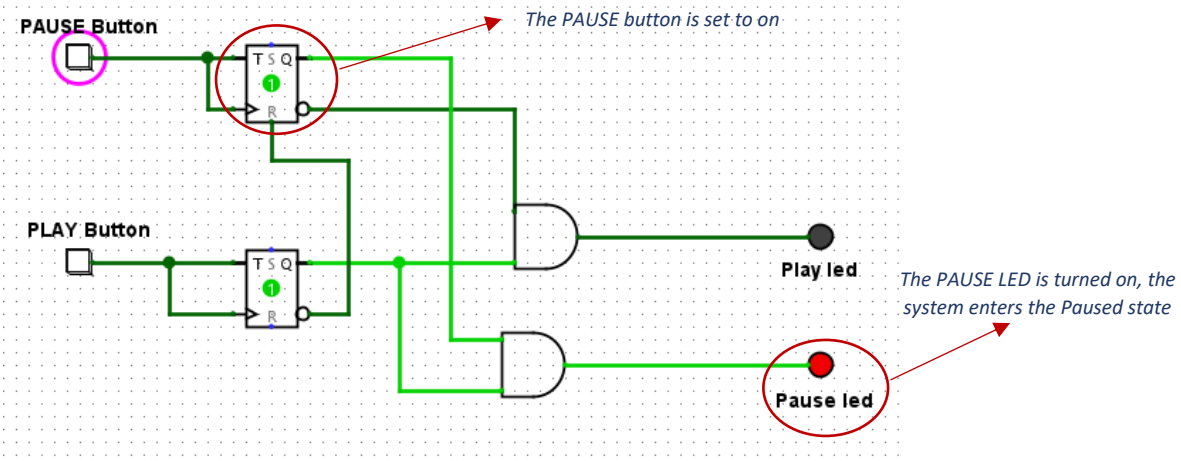
Because Stage 1 requires 2 buttons, 1 PLAY button and 1 PAUSED button. While the stage 4, we only can use 1 button so the stage 1 will not connect to final circuit.

Stage 1A

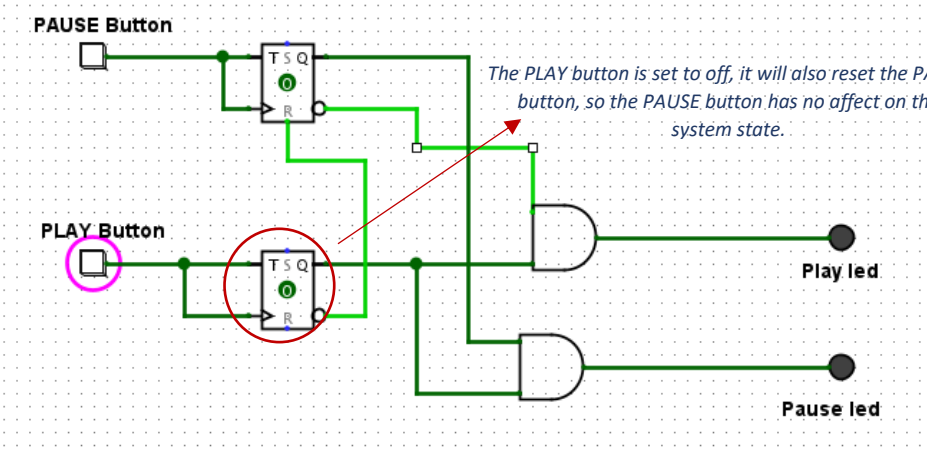
- When the PLAY button is set to on, the system enters the PLAY state:
    - the PLAY LED is turned on
    - the PAUSED LED is turned off



- When the PAUSE button is set to on, the system enters the PAUSED state:
    - the PLAY LED is turned off
    - the PAUSED LED is turned on

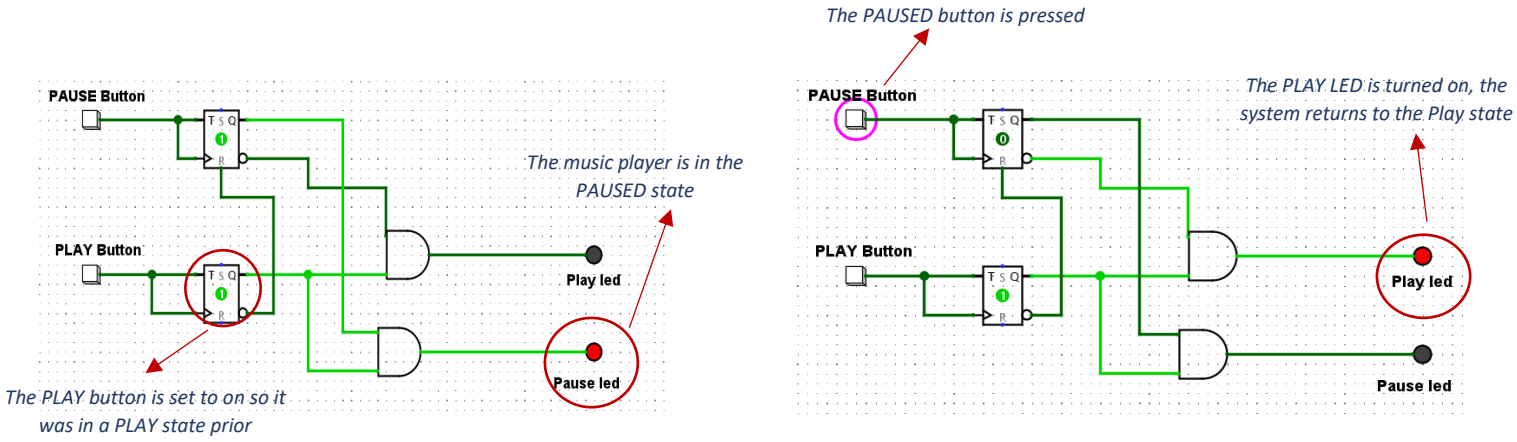


- When the PLAY button is set to off
    - the PAUSE button has no affect on the system state.



Stage 1B

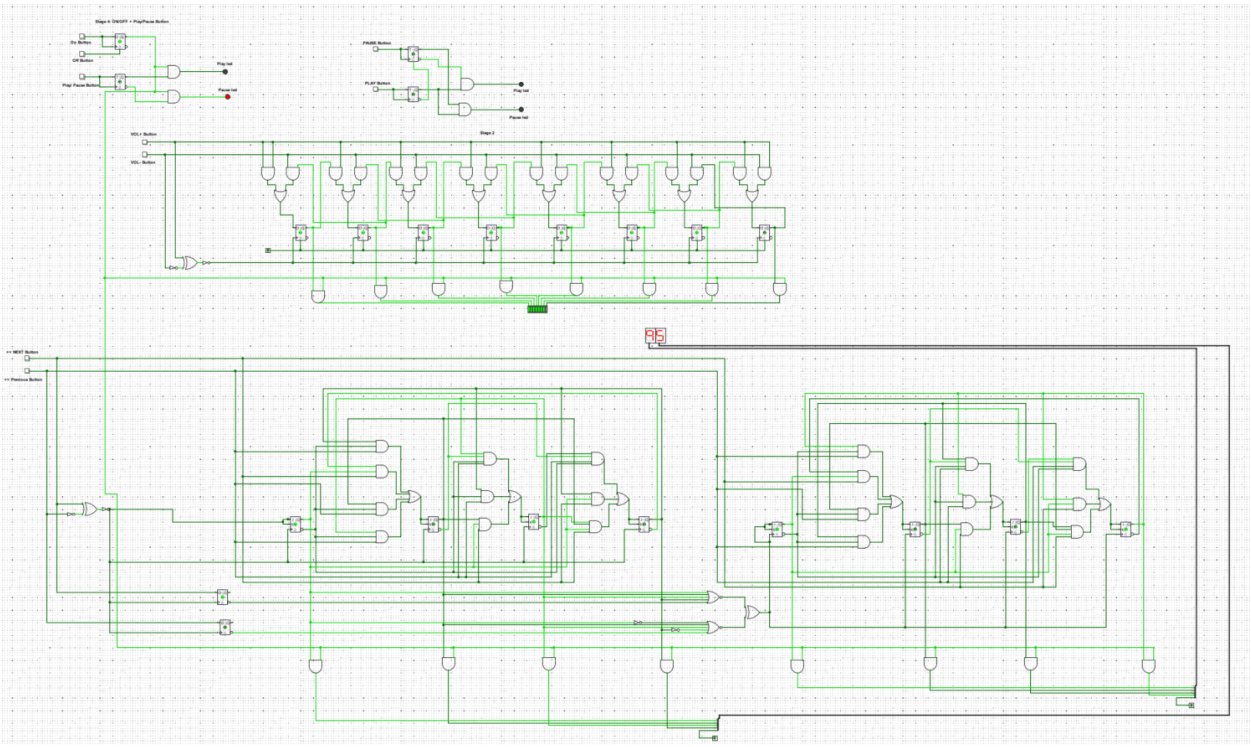
When the music player is in the PAUSED state if the PAUSE button is pressed it will return to the PLAY state if it was in a PLAY state prior, otherwise it has not affect on the PLAY state.



I use T flip flop because it can toggle the On/Off of the PAUSE Button and PLAY Button.

The Play led is triggered when two output connected by the AND gate is set to 1: output Q of PLAY Button and output Q' of PAUSE Button (when the PLAY button is set to on and PAUSE button is set to off)

The Pause led is triggered when two output connected by the AND gate is set to 1: output Q of PLAY Button and output Q of PAUSE Button (when the PLAY and PAUSE button is both set to on)



MUSIC PLAYER CIRCUIT

Unresolved problems with the circuit

Track skipping control can only count between 00 and 99.